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THE MUSCLES AND NERVES OF THE CRYPTOBRANCHUS JAPONICUS. By PROFESSOR HUMPHRY. (Pl. I. to IV.)

BEING so fortunate as to obtain the fine specimen of the great Japanese Salamander which died recently from a gash across its throat in the Zoological Gardens, in Regent's Park, and having the advantage of my friend and assistant Mr Anningson's skill for its dissection, I felt that the opportunity of making a more careful examination of the muscles of the animal with their nerves than had hitherto been done was not to be lost. Hyrtl, in his *Cryptobranchus Japonicus*, 1865, does not describe either the muscles or the nerves, and Drs F. J. J. Schmidt, Q. J. Goddard, and van der Hoeven (*Aanteekeningen over de anatomie van den Cryptobranchus Japonicus*, Haarlem, 1862) do not give any account of the spinal nerves.

The chief interest in the muscular system of this animal (and the other Urodelans) consists in the massing together of the several muscles, or rather the imperfect segmentation and invidualization of them; so that it affords us, to some extent, a natural means of ascertaining the relationships of the muscles of the higher animals to one another, and so of grouping them. In instituting the comparisons requisite for this, it is difficult to exercise sufficient caution, and to avoid the errors which the necessities of nomenclature and the straining for over-exactness of homological interpretation are apt to induce. Especially is this the case if our views are warped by any theory we are disposed to favour. Such influences work upon us imperceptibly; and to be altogether free from them is more than is to be expected, even if it is to be desired. Facts will gravitate from their chaos, and they do so in some minds more quickly, in some in better order than in others; and while we gain the good, we must abide by and beware of the evils of the tendency. I express these thoughts because they have been present with me throughout the investigation of the Cryptobranch.

FASCIAL INVESTMENT.

The muscles of the trunk, tail, and limbs, are covered by an investment of fascia or tough areolar tissue, which is connected with the transverse intermuscular septa of the trunk and tail more closely than with the muscles, and from the deeper strata of which processes pass between the muscles, and are attached to the bones. One of these processes (Fig. 1) forming a sheet or lamina on either side, near the mesial line above, dips downwards, covering the edge of the dorsal muscle, and meets its fellow of the opposite side along the line of the spinous processes of the vertebræ to which the two are attached. They thus enclose a triangular interval between them and the superficial stratum, which is continued across the middle line; and this interval contains fat, and affords a convenient passage for bloodvessels. A similar disposition exists along the ventral mesial line and along the lateral lines in the tail, as we shall find presently. Superficially it is connected with the skin and with the muscular fibres passing from point to point of the skin; and, which is very important to remark, it is closely connected with the *trapezius, latissimus dorsi* and the fore part of the *pectoralis*, as well as with the *subcutaneus colli*, the *depressor mandibulæ*, and the *constrictor faucium*. I say closely connected, because the fibres of these muscles are interwoven with and so take origin from it, and in this respect differ from most or all of the other muscles of the trunk and limbs. In front the fascial investment is continued dorsally, over the head to the margins of the upper jaw; and, ventrally, it is attached to the margin of the lower jaw.

The interior of the trunk is lined by a similar investment (*fascia transversalis*), somewhat more compact, though thinner than that on the exterior, which is connected with the transverse septa extending through the inner layer of the abdominal muscles. It is continued forwards to and along the base of the skull above, and, beneath, over (deeper than and attached to) the branchial cartilages and the hyoid, to the inferior maxilla. Behind it forms a thick fascial stratum inside the pelvis, with which it is connected; and it is continued, between the caudal ventral muscles on the two sides, to the hæmal spines of the caudal vertebræ, where it blends with the mesial ventral process of the external fascial investment[1].

Though thus described as an external and internal investment, these fascial strata are parts of one fibrous system continuous at the oral and anal ends of the animal, and connected with each other along the length of the animal by intervening septa—fibrous, cartilaginous, and osseous—which, though histologically varying, are members of the same system, and in the interspaces between which lie the muscles with their blood-vessels and nerves.

In Fishes and in the Lepidosiren the external fascial investment is, especially at the sides of the body, scarcely developed as a separate stratum, and the transverse intermuscular septa pass through it into the skin and bind the skin with its appendages closely to the lateral muscle. Near the upper and lower edges and immediately over the lateral septum it is more free and more easily detached; and there is frequently subcutaneous muscle present at these parts.

FASCIA AND MUSCLES OF TAIL.

The tail is the simplest part of a vertebrate animal. It consists merely of axially disposed bony pieces or vertebræ which are moveable upon one another, of the muscles which move them, of the nerves which excite and regulate the movements, and of the vessels which carry the nutritive materials to and fro. In Urodelans, as in Fishes, the movements of the bony pieces are restricted, or nearly so, to one plane—a vertical movement in a horizontal plane—and the disposition of the muscles is very simple. The muscles, indeed, composed of longitudinal parallel fibres, are arranged as in the Fish in two flat masses, one on either side of the tail, which may be named after their homologues in the Fish, the 'great lateral muscles.' They are separated from one another, that is, the lateral muscle of the one side is separated from that on the other by membranous septa passing vertically in the mesial line above and below from the vertebræ; and ossifications extending into these septa above and below constitute the 'neural' and 'hæmal' spines.

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[1] These fascial investments, external and internal, are described by Schmidt, Goddard, and van der Hoeven, though not quite in same manner as above.

Each lateral muscle is, as in the Fish, divided into an upper or 'dorsal' and a lower or 'ventral' muscle by a horizontal membranous septum—which may be called the 'lateral septum' —stretched from the sides of the vertebræ nearly midway between the upper and lower edges of the animal, and ossifications extending into these septa on the two sides would constitute 'transverse' or 'lateral' processes. Such ossification however has not taken place except in the fore part of the tail.

Each of the septa (Fig. 1) as it approacees the surface splits into two laminæ which extend in opposite directions beneath the skin and meet and unite with the adjacent laminæ of other septa. Thus the laminæ resulting from the splitting of the neural septum are spread out, right and left, upon the dorsal muscles, and meeting the ascending laminæ from the lateral septa, form sheaths enclosing the dorsal muscles. The same is the case with the laminæ of the ventral septum; and the four muscles, the two 'dorsal' and the two 'ventral' of the two sides, are enclosed in sheaths, more or less distinct, formed by the laminæ of the neural, ventral and lateral septa.

Finally (Fig. 2), the four longitudinal caudal muscles—the two dorsal and the two ventral muscles—are divided transversely by septa, extending with more or less obliquity backwards or forwards from the intervals between the several vertebræ to the enclosing sheaths just described and the skin. So that each of the longitudinal muscles is transversely segmented into pieces corresponding with the several vertebræ. These transverse septa are tough and form as it were part of the muscle itself, being connecting media between the ends of the muscular fibres of the segments. They are not disposed in true vertical planes, but form slight curves with the convexity backwards above and below the lateral septum[1].

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[1] Schmidt, Goddard, and van der Hoeven count 46 of these tendinous inscriptions, 14 or 15 in the trunk, and the remainder in the tail, where the muscular intervals between them are narrower.

It is worth while to remark that the intervals or channels between the diverging laminæ of the longitudinal septa are occupied by fat, and serve as recesses for the passage of blood-vessels, which are thus arranged in four longitudinal trunks or systems—a 'dorsal,' a 'ventral' and two 'lateral.' The interval in the ventral septum is thicker than in the other parts, and the fat-mass occupying it is larger and extends in upon the stunted or bifurcated hæmal spines. A transverse system of blood-vessels lies upon the transverse septa; and the several transverse vessels being connected with the four longitudinal trunks form communications between them, and discharge their blood into them.

In addition to the four fat-masses disposed with the longitudinal series of vessels are four deep fat-masses lying beneath the four lateral muscles, and lying therefore above and beneath the transverse processes and lateral septa. The nerves, as they pass from between the vertebræ transversely to the muscles, cross superficially with regard to these deep fat-masses.

The several fat-masses serve the purpose of giving size and lightness to the tail, making it a large and, by reason of the muscles, powerful propelling organ. Each attains its maximum thickness near the middle of the tail and diminishes towards the tip.

The caudal muscles therefore consist of a 'dorsal' and 'ventral' muscle on each side, passing from behind forwards, and transversely segmented by the membranous septa and the vertebral processes running into it.

The several parts, muscular and other, of the animal above the level of the lateral septa present but little variety in different regions of the tail, or indeed in the different regions of the animal. Accordingly the dorsal muscle extends in the simple form I have described along the whole length of the tail and indeed onwards through the abdominal and thoracic regions to the head.

The parts of the animal beneath the level of the lateral septa, on the contrary, undergo various and extensive modifications in consequence of the presence of the limbs and the abdominal thoracic and cervical viscera, which are all placed in the ventral division, that is in the division of the animal beneath the plane of the transverse vertebral processes and the transverse or lateral septa connected with those processes. The effect of these modifications is seen in the fore part of the ventral muscle of the tail. Behind and in the greater part of its extent it, like the dorsal muscle, is simple. Anteriorly, however, it is more or less interrupted and broken up by the proximity of the pelvis and hind limb.

The upper portion of it encounters the ilium, which is developed in the middle of the thickness of one of the transverse septa; and the middle stratum of this portion of the muscle is interrupted by or inserted into it and constitutes the *ilio-caudal* muscle. The superficial stratum is continued forwards over the ilium, and being expanded, together with the rest of this part of the animal for the accommodation of the viscera, contributes to the formation of a layer of the abdominal muscles. The deepest stratum is continued forwards beneath the ilium, is similarly expanded, and joins the deepest stratum of the abdominal muscles.

The undermost part of the ventral muscle, the part lying next to the ventral fat-mass, becomes separated from the remainder as it approaches the pelvis and hind limb, loses the transverse inscriptions, and divides into three. Of these one—'*ischio-caudalis*'—situated nearest the middle line and the most superficial, arises from the extremities of the hæmal spines and is inserted into the hindermost margin of the ischium[1]; a second division—'*caudo-cruralis*'—arises a little more laterally from the hæmal spines and arches and loses itself in the superficial stratum of the hinder part of a broad muscle (Figs. 8 and 9), which is passing from the pelvic shield to the hind limb. It cuts this muscle nearly at right angles, and being inserted tendinous into it produces a tendinous inscription in it. A portion, however, of the caudo-crural does not lose itself in the broad muscle just mentioned, but is continued on along the hinder aspect of the thigh and leg into the musculo-tendinous mass of the sole, and so on to the extremities of the digits. It may be called '*caudo-pedalis*,' and it constitutes a continuous muscle reaching from the middle of the tail to the ends of the toes. Its fibres are partially interrupted by a tendinous inscription, and it is joined beyond that point by a portion of the muscle arising from the ischium in which there is no tendinous inscription. (Fig. 10.)

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[1] It arises rather from the side of the ends of the hæmal processes, being separated from the muscle of the opposite side by the fat-mass which lies upon (beneath) the middle parts of the extremities of the hæmal processes.

The intervals between the hæmal spines are occupied by short antero-posterior 'interspinous' muscles, which form part of the ventral muscle, and the marginal fibres of which are continued into the ischio-caudalis.

The third division—'*caudo-femoralis*'—arising somewhat more laterally and deeply from the hæmal arches, is inserted by a strong tendon into the middle of the under (plantar) surface of the femur.

This disposition of the caudal muscles corresponds with that in the other Urodelans[1] (Axolotl, Menobranch and Newt) which I have examined; the only difference being, that in these the upper and larger—the iliac—portion of the ventral muscle does not afford so thick a covering stratum to the ilium, and consequently that bone, occupying as it does in Cryptobranch the plane of one of the intermuscular septa, approaches nearer to the surface. Internally the ilium is, as in Cryptobranch, lined by a deep stratum of the caudal muscle which is continued into the abdomen.

The TRANSVERSE INSCRIPTIONS or 'sclerotomes' which, in these animals, as in the fish, divide the lateral muscles into so many 'myotomes,' serve the purpose of binding the muscles throughout their whole length and depth to the vertebral column, preventing their starting from the column towards the arc of the curve, or their having a tendency to do so, when the tail is bent to one side or the other under their contraction; also by preventing the continuity of the muscular fibres, and by diffusing among many the force of the pull consequent on the contraction of any one, they add greatly to the strength of the whole. It is obvious that if each muscular fibre had been continued from end to end of the animal, and, further, had been required, as must be the case in these animals, and in fishes especially, to contract in its whole length simultaneously for the purpose of effecting those energetic violent flexures which produce the dartings and leapings of these animals, it would have been liable to rupture under its own force. The interruption however of the fibre by an inscription common to it with others diffuses the pull of the several parts of each fibre among many, and enables them all better to combine in a simultaneous effort. The arrangement does not interfere with the nerve-supply because each myotome receives its own nerves from its own division of the spinal cord through its vertebral foramen, in addition to the filaments from the lateral nerve which travels along the lateral septum to the tail and then

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[1] It corresponds also generally with the account given by Mr Mivart of the Menopoma and Menobranch, *Proc. Zool. Soc.* April 22 and June 24, 1869.

breaks up into branches (p. 47). When, however, as in the case of the caudo-femoral, caudo-crural, &c., a part is segmented from the rest for the purpose of independent action requiring independent nerve-supply, then, partly for the better distribution of the nerves through its substance, the inscriptions disappear, the continuity of the muscular fibres being established through them so as to cause their obliteration. It is probable also, taking into account the peculiar vibratory or successional manner of action of the several parts of a fibre by which sustained contraction is effected, that continued action may have relation to continuity of independent fibres; whereas violent sudden efforts are associated with interruption of fibres, or, as in the case of the heart, with interlacing and intercommunication of fibres, which would have much the same effect. Practically, at any rate, we find where sustained action is required the muscular fibres are parallel and uninterrupted, but where sudden violent efforts are needed the fibres are interlaced and communicating, or are segmented by transverse tendinous inscriptions.

It is obvious that just as the extension of the muscular fibres through or over the tendinous inscriptions would cause fusion or ankylosis of the myotomes, and the occurrence of this partially and in varied ways will lead to varied dispositions and divisions and complications of the muscular structure: so the extension of the tendinous inscriptions through or over the myotomes would cause fusion or ankylosis of the sclerotomes; and the ossification of the thus extended sclerotomes may lead to varied prolongations and complications of the bony skeleton.

I have mentioned incidently that the limb-girdles and the limbs are placed beneath the lateral septa in connection with the ventral parts of the lateral muscles and have little or no relation to the dorsal parts, that the same is the case with the ribs, and that the iliac bones are, like the ribs (pp. 6 and 10), the result of ossifications in the ventral transverse intermuscular septa. It does not hence follow that the iliac bones are precisely the serial homologues of the vertebral ribs or 'pleurapophyses.' An objection to that view is presented by the fact that there intervenes in the Cryptobranch and other Urodelans, between the iliac bones and the vertebral transverse processes on either side, a distinct bone which must correspond with a rib, and which in Menobranch has the elongated characters of a rib. This, together with the ventro-mesial position and relations of the pelvic bones and their freedom from the vertebral column in some animals (Whales, Snakes and Lepidosiren), indicate a serial correspondence with the skeletal formations in the sternal rather than with those in the vertebral ('pleurapophysial') region of the visceral wall. I avoid applying the term 'hæmapophysial' to the former because I think it by no means clear that the visceral cavity and its wall are to be regarded as identical with the hæmal canal and its wall. Indeed, as stated above, the lining of the visceral cavity (*fascia transversalis*) in the Cryptobranch is continued from the interior of the pelvis beneath the hæmal arches of the tail where it blends with the subhæmal septum; and the position which a backward or caudal prolongation of the visceral cavity would occupy appears to be that occupied by the ventral or subhæmal fat-mass. If this view is correct the visceral wall represents a stratum superficial to that of the hæmal wall; and the hæmapophyses, instead of being in the same plane and corresponding with the lower parts of the visceral wall, or, instead of being expanded to the level of those parts—the pelvis, linea alba, sternum and sternal ribs, shoulder-girdle, and hyoid apparatus—are rudimentary or abortive in the visceral region. The representatives of them are to be sought in the fibrous structure covering the aorta and its branches, and lining the crura of the diaphragm, not in the subvisceral part of the wall of the viceral cavity.

THE MUSCLES OF THE TRUNK.

The muscles of the trunk may clearly be regarded as, in part at least, formed by an extension of the caudal muscles forwards. Like these they are divided by a 'lateral septum' into a 'DORSAL' and a 'VENTRAL' series; and the former present very little difference from those in the tail. The septum is continued from the extremity of the tail forwards, beneath the *latissimus dorsi* and the muscles passing from the dorsum of the head and spine to the scapula and over the neck, as far as the head. The fibrous sheet which forms it slants from the exterior somewhat upwards to the upper surface of the ribs and transverse processes, so that the dorsal series of muscles overlaps the ventral to a slight extent: and owing to the greater expansion of the inferior or ventral part of the trunk, in comparison with that of the upper or dorsal part, the lateral septum is here situated nearer to the dorsal than to the ventral edge of the animal.

The TRANSVERSE SEPTA, a serial continuation of those in the tail, are directed from the median line above, at first very obliquely outwards and backwards through the inner part of the dorsal muscles; gradually, as they pass over the ribs they become less oblique, describing a curve with the convexity backwards, and near the lateral septum they are almost transverse. Beneath the lateral septum they are continued with slight obliquity backwards, and then again become transverse, thus forming in the ventral region a gentle curve with the convexity backwards, like that which is seen in the dorsal and in the ventral muscle of the tail. The direction therefore is not so zigzag as in the fish, or quite so much so as represented by van der Hoeven. Viewed from the interior of the trunk they are seen to be directed from the mesial line, on either side, over the several intervertebral substances, obliquely backwards and outwards, upon the bodies of the vertebræ and over the ribs, in a direction corresponding with that of the transverse septa on the corresponding part of the exterior. Indeed they are a continuation of them through the thickness of the animal. They are easily traced down to the ribs, and the ribs appear to be the result of ossification occurring in them, beneath the plane of the lateral septum, that is, in the ventral parts of them. Beyond the extremities of the ribs the direction is rather suddenly changed, becoming more transverse; and towards the middle line they are, as on the exterior, quite transverse. (Fig. 4.)

DIRECTION OF THE MUSCULAR FIBRES.

In the DORSAL series (above the lateral septum) the direction of the muscular fibres is parallel with the axis of the animal. As in the tail, they simply pass between the transverse intermuscular septa and between the vertebral processes, and show no distinct indications of grouping into distinct bundles or muscles. They are moreover not interrupted by the presence of the limb-girdles. They require therefore no special description.

In the VENTRAL series (beneath the lateral septum) however the case is different. The intermuscular septa preserve their serial order, that is, follow one another in regular succession, as in the dorsal series, and are continued through the entire thickness of the muscular wall of the abdomen, and the muscular fibres pass from septum to septum, being limited to the intervals between the septa; but the muscular wall is expanded to cover the abdominal cavity and accommodate the viscera, and it is interrupted, or partially interrupted, by the limb-girdles; moreover, the direction which the muscular fibres take between the septa varies in different *parts* of the abdominal wall, and at different *depths* of the same part. The difference in direction at different *depths* causes a more or less distinct division into *planes;* and the difference in direction at different *parts* of the abdominal wall causes a more or less distinct division into *sectors*.

Near the exterior the muscular fibres are directed, between the transverse intermuscular septa, from before backwards, and ventrally towards the linea alba. This disposition distinguishes them from those of the subjacent layer which take a different direction, and gives rise to a stratum constituting an '*obliquus externus*' muscle. The obliquity is most marked near the lateral septum. At a distance from that it gradually diminishes, and near the mesial line the fibres acquire an antero-posterior or straight direction, and constitute a superficial layer of the '*rectus abdominis*.'

In the stratum next subjacent the fibres are directed from before backwards, and dorsally towards the lateral septum, and thus is constituted an '*obliquus internus*.' The obliquity is here also more marked near the lateral septum diminishing towards the mesial line; and the fibres here acquiring an antero-posterior or straight direction constitute a deeper layer of the '*rectus*.'

The '*rectus abdominis*' is therefore simply the resultant of the altered direction of the fibres of the internal and external oblique, and consists of two layers which may, to some extent, be separated from each other, and which are continuous respectively with the external and internal oblique muscles[1]. (Fig. 7.)

In the deepest stratum of all the muscular fibres with their intermuscular septa extend, under the surface of the bodies of the vertebræ, as far as the middle line. In this situation they are directed antero-posteriorly or straight, and constitute what may be designated a '*subvertebral rectus*[2].' More laterally, where they lie beneath the ribs and are connected, by means of the intermuscular septa, with the ribs, they acquire a slant from behind outwards as well as forwards, and constitute a series of '*depressores costarum.*' More laterally still the obliquity increases to an almost transverse direction. This part of the stratum is the '*transversalis abdominis.*' Towards the linea alba it degenerates into a fascial layer, which is continued above (on the deeper aspect of) the *rectus abdominis* to join its fellow in the middle line.

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[1] It would be more strictly correct to say that the *obliqui* are the resultant of an altered direction of the fibres of the *rectus*, and the two layers which they form are consequent on the difference in the direction which their fibres respectively take in their variation from the antero-posterior course of those of the *rectus*.

This fusion of the external and internal oblique muscles with the rectus, which I have indicated diagrammatically in Fig. 7, was pointed out by Mr Mivart in his description of the Menopoma, *Proc. Zool. Soc.*, April 22, 1869, p. 258, as well as in that of the Iguana, *Proc. Zool. Soc.*, 1867, p. 770.

[2] This muscle is described as *rectus trunci internus* by Schmidt, Goddard, and van der Hoeven; but they do not mention its connection with the *transversalis*. By Mivart it is regarded, in Menopoma (*Proc. Zool. Soc.*, April 22, 1862, p. 260), as part of the *retrahens costarum*.

The nerve-trunks lie in the chief part of their course behind the intermuscular septa, between the internal and the middle muscular planes, *i.e.* between the *subvertebral rectus*, the *depressores costarum* and the *transversalis*, on the one side, and the *internal oblique* on the other. (Fig. 4.)

It will thus be perceived that the muscular fibres lying nearest to the mesial plane of the animal, ventral as well as dorsal, are directed antero-posteriorly, corresponding with the axis of the trunk, and constitute so many pairs of '*recti*,' 'supra-vertebral,' 'sub-vertebral,' and 'sub-abdominal;' whereas the fibres more laterally situated are oblique, and constitute *obliqui* and *transversi*. This accords with the directions in which the muscular forces are required to operate in the mesial and lateral planes.

It will be perceived further that the several abdominal muscles are essentially one, transversely segmented, muscular mass, that the stratification or segmentation into planes is simply the result of the variation in the direction of the fibres at different depths, and that the *recti* differ from the *obliqui* and *transversi* only in the circumstance that this variation in direction at different depths has not occurred in and near the mesial plane of the animal where they are situated. In the Fish where the variation in direction does not commonly take place at any part, not being required by the form and movements of the animal, the '*rectus*' character pervades the whole of the ventral muscular system of the trunk, and there are no *obliqui* and *transversi*.

Lastly, the stratification, even in the lateral parts of the Cryptobranch and other Urodelans is incomplete, intermediate between the condition of the Fish and that of the higher vertebrates, forasmuch as it affects only the muscular fibres, and does not extend to the intermuscular septa. In Birds and Mammals, where more independent action, not only of the several strata, but of the several parts of each stratum, may be presumed to take place, the stratification is more complete, and the septa have in great measure disappeared. Still even in them the subabdominal *rectus* retains commonly more or less of the original septal and unstratified type. The persistence of these characters in it contrasting so markedly with the alterations which have been wrought in the more lateral muscles, and the consequent complete separation of the one from the other, mask the natural relations of the several abdominal muscles, and make us overlook the fact that they are all derivatives from one simple antero-posteriorly disposed muscular mass.

DESCRIPTION OF THE ABDOMINAL MUSCLES.

The obliquus externus (Figs. 2, 3, 5, 7) may be described as arising from the extremities and outer surfaces of the ribs from the second to that just in front of the pelvis, inclusive, by digitations, of which the foremost are very distinct. Further backwards the digitations are less distinct, and the muscular fibres arise partly from the lateral septum as well as apparently, to some extent, from the fascial tissue covering the dorsal muscles; this however is not quite clear. Joined by a more superficial portion from the ventral surface of the thorax[1], it extends over the side of the abdomen to the middle line and the edge of the prepubic shield and cornu. The fibres, for the most part oblique, are near the middle line antero-posteriorly disposed, blended with, or constituting the superficial layer of the *rectus*. The hinder part of the muscle, dorsally, is not very defined, being partly attached to the ilium and partly lost in fascial tissue: ventrally it is attached to the edge of the prepubic shield and cornu superficial to the *pyramidalis:* and it is strongly attached to the spinous or marsupial tubercle which projects forwards from the hinder part of the edge of the prepubic shield. It is also continued into the *gracilis,* which arises from the under surface of the prepubic shield and pubes; and it is attached to the ala of the ilium, while some of the fibres passing over it are lost in fascial tissue; and between the ilium and the gracilis or pubes it is continued into the fascial tissue, which spreads over the dorsal aspect of the thigh, knee and leg. A deeper portion extends from between the anterior edge of the ilium and the pubic spine as a fibrous process, which acquires close connection with the hip-joint. (Fig. 2. *e*, *o'*.)

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[1] This is the pectoral muscle, see p. 32.

If it is traced in the opposite direction, it may be described as radiating from the sides of the prepubic cartilage and the pubes, anteriorly and dorsally. The fibres nearest the middle line run forwards as *rectus*, having a slight connection with the sternum, and are continued beneath, *i.e.* superficial to the coracoid of the same side, forming the superficial thoracic portion mentioned above. Some of these are lost upon the fascial tissue of the coracoid; but the greater number diverge laterally and are attached to the humerus, contributing largely to the formation of the *pectoralis major*. The fibres of the oblique situated more laterally than these take a deeper course, above the coracoid, and are attached to the extremities of the ribs as far forward as the second. Thus the fore or under part of the scapular arch (the hinder portion of the coracoid) projects back between the '*recto-pectoralis*' and the '*obliquus*' divisions of the oblique muscle. The fibres of the oblique arising still more laterally, are directed with increasing obliquity upwards to the ribs, the lateral septum, and the dorsal fascia, and backwards to the ala of the ilium and the fascial tissue of the thigh.

It will be understood that this, which we call a single muscle, is composed of successional series of fibres or myotomes passing from rib to rib and from transverse line to transverse line, the transverse lines being continuous with the ribs.

Obliquus internus. (Figs. 2, 4, 5, 7.) If the fibres of the external oblique are cut through, the subjacent stratum of fibres taking a different direction, viz. from behind forwards and *in*wards and constituting the *obliquus internus*, is disclosed without difficulty, forasmuch as the change in direction takes place abruptly.

The internal oblique is more massive than the external oblique, and more obviously a continuation of the iliac part of the caudal ventral muscle. Indeed that muscle, or great part of it, is continued forwards into the internal oblique, the ala of the ilium, which constitutes the notable line of demarcation between the two, not being seen on the exterior or the interior, and being, as before said, apparently an ossification in the thickness of the intermuscular septum.

The *internal oblique* may be described therefore as arising from the upper part of the ala of the ilium, from the iliac part of the caudal ventral muscle passing above and beneath the ala of the ilium, and from the several ribs, as far forwards as the fourth, in a deeper plane than the external oblique. Its origin does not however extend so far forwards by two ribs as that of the external oblique. The fibres are, in the lateral part of the animal, directed obliquely from behind forwards and inwards, or mesially between the intermuscular septa; but near the ventral mesial line they take a more antero-posterior direction, constituting the deep stratum of the *rectus*. The hindmost fibres in this manner join or contribute to the rectus, in front of the prepubic cartilage and cornu, and are therefore not attached directly to the pubes. Anteriorly it is continued beneath the abdomen and thorax into the neck passing above, that is deeper than, the coracoid to the branchial cartilages and the hyoid. Its mesial part—the part forming the deeper stratum of the rectus—when passing above the coracoid comes into contact with and is attached to the deeper plate of the sternum[1], the edge of the plate being received among its fibres; and between this point and the hyoid apparatus, it forms the *sterno-hyoid*. As it travels forward in the neck it is joined, near the hyoid, by a narrow muscle from the anterior edge of the scapula, which is the *omo-hyoid*. (Fig. 5, *o. h.*) Or, the relations of the omo-hyoid to the internal oblique may be more clearly expressed by stating that as the latter muscle proceeds backwards from the hyoid a portion is detached to, or acquires an attachment to, the fore part of the scapula and forms the omo-hyoid.

The hinder and inferior margin of the internal oblique passing from the ilium to form the deeper stratum of the rectus, is tolerably defined; and there is an interval between it and the retiring angle of the pubes and prepubic shield, which is occupied by the *Pyramidalis*. (Fig. 2. *Py.*) The fibres of this muscle, arising from the anterior edge of the pubic shield and the tubercle or spine[1] which bounds that edge laterally, pass forwards and inwards to the edge of the prepubic cartilage and cornu, and some of them are continued further forwards, blending with the edge of the *rectus*. It lies between the external oblique and the transversalis, its outer margin being parallel with, though at a short distance from, the inner margin of the internal oblique. Its fibres take the same direction as those of the internal oblique and are in the same plane with them and appear to belong to the same series. In the Axolotl this is proved to be the case by the continuity between the two, that is, by the absence of the interval which separates them in the Cryptobranch.

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[1] The sternum (Fig. 5) is a very rudimentary structure, consisting of a broad heart-shaped plate of cartilage, with the rounded apex directed forwards; and it is deeply notched or cleft on either side anteriorly for the reception of the edges of the large coracoids. So deeply is it cleft that it might be regarded as consisting of two plates, a superficial and a deeper, blended in the middle line and behind. It is the deeper plate which is involved at its margin in the internal oblique. The clefts on the two sides are not quite in the same plane, that of the left side extending a little beneath that on the right side. This permits the edge of the left coracoid to pass superficially to or beneath the right.

The *Transversalis* (Fig. 4) is connected with the ribs and the transverse intermuscular septa in a still deeper plane. Near the vertebral column the direction of its fibres is nearly antero-posterior, and they are with difficulty distinguished from those of the internal oblique; still the division between the two is marked by the passage of the nerves. More externally their slant first resembles then exceeds that of the fibres of the internal oblique (from behind forwards and inwards), and finally they become almost transverse. At about an inch and half from the mesial line, at a part that is corresponding with the formation of the *rectus* in the manner I have described, the muscular fibres of the *transversalis* end in a tendinous sheet which is continued above (deeper than) the *rectus*, to join its fellow in the middle line. Anteriorly the *transversalis* takes origin from the ribs as far forwards as the internal oblique; and it forms a thin sheet passing above the coracoids and the sternum. It is separated from the coracoids by the internal oblique; but it comes into contact with the deeper surface of the sternum near the mesial line. A space is here left uncovered in consequence of the fibres of the internal oblique being limited to the margin of the deeper plate of the sternum, and the *transversalis* accordingly is attached here. In front of this it blends with the internal oblique or is lost in areolar tissue. Towards the hinder part of the abdomen it is inserted into the upper surface of the prepubic cartilage and cornu in a manner corresponding with its attachment to the upper surface of the sternum; and it is traceable within the pelvis in company with the deepest stratum of the internal oblique into connection with the caudal muscle.

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[1] The relation of the muscles shows this lateral prepubic tubercle to be the homologue of the spine of the pubes in man, and of the marsupial bone in marsupials. I have dissected the muscles of this part carefully in the Wombat, Paracyon, and Echidna, and find that the external oblique fibres forming the outer columns of the external ring are inserted into the outer edge of the marsupial bone, whereas the fibres forming the internal column pass across to the base of the marsupial bone of the opposite side and interlace with the corresponding fibres of the opposite side. The *pyramidalis* muscle, which is large in most of these animals, arises from the inner edge of the marsupial bone, and extends forwards and inwards in front of the rectus and behind the external oblique to the middle line, becoming blended with the rectus posteriorly so as not to be easily distinguished from it. In these animals, with the exception of the Wombat, the internal oblique has no connection with the marsupial bone and the pyramidalis, but passes deeper than they, and deeper than the rectus. In the Wombat a few of the hindmost fibres of the internal oblique are connected with the marsupial bone.

Where the fibres of this deepest or *transversalis* stratum of the abdominal muscles lie beneath the ribs passing from rib to rib, directly or through the medium of the intermuscular septa in which the ribs lie, and passing from the sides of the vertebral bodies to the ribs, they constitute a series of *depressores costarum* (Fig. 4, *D*, *C*); and where they lie beneath the bodies of the vertebræ they constitute what I have called a *subvertebral rectus*. In the former situation (where they form the *depressores costarum*) they slant from behind forwards and outwards like the fibres of the internal oblique; but in the latter situation (where they form the *subvertebral rectus*) they take a more antero-posterior direction. The subvertebral rectus is continued forwards beneath the bodies of the cervical vertebræ and is attached to the skull, so constituting a *longus colli* and *rectus capitis*. It will be understood that there is no line of demarcation between these several muscles, the whole—*transversalis*, *depressores costarum*, *subvertebral rectus*, *longus colli*, *rectus capitis*—being one continuous sheet of muscular fibres, with transverse septa or inscriptions, extending beneath the vertebral column, forwards, as far as the head, backwards, into the caudal muscles, and continued laterally beneath the internal oblique to the ribs, the ventral mesial line, the prepubic cartilage, and the sternum.

Mesially, beneath the vertebral bodies, the muscle is separated from that of the opposite side by an interval in which lie longitudinal subvertebral vessels. Branches from these vessels pass transversely between the several vertebral bodies and the subvertebral rectus supplying both, and are continued as 'intercostal' and 'lumbar' vessels in company with the nerves, behind the intermuscular septa, between the transversalis and internal oblique.

There can, I think, be little doubt that the *crura* of the *diaphragm* in Mammals are formed by the lumbar parts of the *subvertebral rectus* bending downwards on the sides of the aorta and encircling it, and that the lateral parts of the diaphragm are in like manner formed by the inflection of the lateral parts—the *depressores costarum* and *transversalis* parts—of the same sheet.

A series of muscular fibres extending forwards to the head in the plane of, and taking the same antero-posterior direction as, those of the external and internal oblique near the vertebral column and forming a continuation of them, constitute the *scaleni* and the *recti laterales.* They pass between the transverse processes, between the ribs and between the intermuscular septa, and are separated from the *rectus capitis* (the anterior part of the subvertebral rectus) by the emerging nerves.

MUSCLES OF THE HIND LIMB.

The muscles of the hind limb are, in accordance with the chief movements of the several parts of the limb, arranged in two series, one upon the plantar and the other upon the dorsal aspect of the limb; and in the furrows between the two, along the anterior or tibial and the posterior or fibular edges, are contained the chief blood-vessels and nerves of the limb. This at least is the case in the thigh; in the leg and foot they lie more near the middle of the dorsal and plantar aspects of the limb between the superficial and the deep strata of the muscles.

PLANTAR MUSCLES OF THIGH.

In the thigh the plantar mass arises from both surfaces—the upper or abdominal and the inferior surfaces—of the under or sub-costal parts of the broad pelvic shield, that is, from the region of the pelvis situated on the ventral or plantar side of the hip-joint, and consisting of the ischium and the pubes. The mass is continued anteriorly into the *obliquo-rectus* muscle of the abdomen, and posteriorly is connected with the *caudo-crural* muscle. It thus intervenes between and connects (or may be regarded as an extension of) the mesial portions of the ventral muscles of the abdomen and the tail.

It is divided into two STRATA. Of these the SUPERFICIAL is a large, broad, unsegmented, and thick mass. It arises from near the mesial line of the large pelvic shield in nearly its whole length, from the insertion of the *ischio-caudal*, behind, to the *external oblique*, with which it is blended, in front. The greater part of it (all of it except the fibres presently to be mentioned as joining the *caudo-pedal*) is inserted into the upper two-thirds of the anterior (tibial) edge of the tibia inclining to the plantar aspect. It is the great flexor and adductor muscle of the leg, and corresponds with the *gracilis*, *semitendinosus* and *semimembranosus*. About one-third from its origin it is joined nearly at right angles by the fibres of the *caudo-crural* (p. 6, Fig. 8), which, or the greater number of them, terminate, tendinous, in its hinder and superficial part, causing a tendinous inscription in it.

The hinder part in which the caudo-crural thus terminates appears to correspond with the *semitendinosus*, the anterior superficial part being referable to the *gracilis* and the deeper part to the *semimembranosus*; and I cannot but suspect that the inscription thus formed may afford a more probable explanation than has yet been given of the remarkable inscription in the *semitendinosus* of man. If it be so it is a curious illustration of how far back in the animal series we may search for the explanation of peculiarities in the human frame, and, further, of the fact that minor features may appear or reappear and be the only trace of those conditions in the general plan of development which seem to have been their cause; for I need scarcely say that of the *caudo-crural* muscle itself there is no trace in man.

A bundle of the fibres of the hinder part of the muscular mass we are considering, unmarked by an inscription, joins a similar bundle from the *caudo-crural*, which is to some extent marked by an inscription, and they together form the *caudo-pedal* (Figs. 3 and 10). This runs down the back of the leg and expands into the fascia of the leg and sole, reaching to the extremity of the digits. There is thus one continuous muscle extending from the middle of the tail to the ends of the digits, deriving occasional fibres in its course from the pelvis, and, as we shall find, from the femur, the leg-bones, and the tarsus.

The DEEPER STRATUM of the plantar mass is in three parts. A middle part arises beneath (deeper than) the preceding from the under surface of the pelvic shield. It is large, covers the obturator hole, and receives the nerve emerging from that hole. It is inserted into the tibial side and middle line (*linea aspera*) of the plantar surface of the femur and into a line passing from the *linea aspera* to the tibial condyle. It represents the *adductors* and the *external obturator*. A hinder—ischio-femoral—part arising from the hinder edge of the ischium is inserted rather above and behind the preceding into the projection on the fibular side of the upper end of the femur. It represents the *quadratus femoris*, the *gemelli*, and the *internal obturator*. It is separated from the contiguous edge of the dorsal muscular mass, or the ilio-femoral portion of it, by the sciatic nerve, which lies between them, as it passes from the interior of the pelvis. An anterior—supra-pubic—portion representing the *pectineus* (Fig. 2, *Pect.*) arises from the whole of the upper or abdominal surface of the pubes, behind the pubic spine and the *pyramidalis*, not therefore from the prepubic cartilage. It here extends as far as the middle line, meeting its fellow of the opposite side. It is a large muscle, passes over the anterior edge of the pubes and the inner part of the hip-joint, and is inserted into the *linea aspera* and tibial side of the plantar surface of the femur in conjunction with the middle portion. Moreover, it expands over the dorsal surface of the lower third of the femur, immediately above the knee-joint. It here extends round the fibular side of the femur, as far as the plantar or popliteal surface, and therefore nearly embraces the lower part of the shaft of the femur. Where it passes over the fore part of the pubes it is separated from the middle, or adductor, portion of its stratum by a prolongation of the tendon of the external oblique which extends from the spine of the pubes, along the anterior margin of the pubes, to the hip-joint[1].

DORSAL MUSCLES OF THIGH.

The dorsal muscular mass is, above, connected with the supra-coxal part of the pelvis, *i.e.* with the ilium. Below, it is partly connected with the femur and partly extends upon the leg. This causes a division, as in the plantar mass, into a SUPERFICIAL or ILIO-CRURAL and a DEEP or ILIO-FEMORAL STRATUM.

The SUPERFICIAL STRATUM is divided into three long bands or sectors. The inner (Fig. 2, *R*, *i*), arising by a flat tendon from the pelvis over the hip-joint, external to the *pectineus*, descends over the anterior or tibial part of the knee close to the joint, and passing beneath the origin of the *tibialis anticus* from the femur is inserted into the dorsal surface of the head of the tibia, close to the knee. I name this *rectus femoris internus*, and judge that it corresponds with the so-named muscle in Birds. It has no distinct representative in mammals, though its insertion nearly resembles that of the *sartorius*. It acts as an extensor of the leg.

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[1] This is not the *ligamentum teres*. Indeed, I do not find so distinct a representative of that ligament either in the hip or the shoulder as figured and described by Hyrtl (Tab. v. fig. 8, and Tab. vi. fig. 1). In the femur and the humerus the cartilage forms a broad horse-shoe belt over the somewhat flattened upper end of each; and into the concavity of the crescent on either side, which is thus left uncovered by cartilage, the capsule of the joint ascends higher than at other parts of the circumference of the bone. The fibrous tissue of the capsule is also rather thick at these parts and so forms ridges, as it were, projecting into the joint, and passing from the head of the bone upwards and downwards, to the ilium and to the ischium in the case of the hip, and to the scapula and to the coracoid in the case of the shoulder. Suppose the ends of the cartilage horse-shoe to be prolonged in either instance and to meet forming a circle, enclosing a central dimple, and cutting off from the rest of the capsule the projecting portion of it inserted into that dimple, a veritable *ligamentum teres* would be formed. This might take place either above or below. It does so below, towards the ischium, commonly in the hip; and in the shoulder, a projection of the capsule forming the gleno-humeral ligament towards the upper or scapular side presents an approach to the same thing, and is a reminder of the parts in the Cryptobranch. In the *Journ. of Anat.* IV. 28, I have called attention to a recess and dimple in the astragalus of Unau and of Ai. They are similar to these in the humerus and femur of Cryptobranch; and with these are associated in each animal a similar approach to the formation of a *ligamentum teres* from a part of the posterior peroneo-tarsal ligament which ascends into the recess and dimple.

If this is, as I believe, the true explanation of the *ligamentum teres*, we must regard that ligament as merely a detached portion of the capsule of the joint, and not, as has been suggested, the representative of a tendon or other structure.

The middle sector (Fig. 2, *Gl.* 2) arises from the outer surface of the ilium, half an inch from the hip-joint, and descends as a broad strap-like muscle over the thigh and over the middle of the knee, superficial to the inner sector and the origin of the dorsal leg-muscles from the femur. It does not acquire any attachment to the upper end of the tibia, being separated from it and from the knee by the dorsal muscles of the leg, extending up to the femur; but it expands over those muscles and sends a process deeper, between the *tibialis anticus* and the *extensor digitorum,* which is attached to the lower end of the tibia and expands upon the ankle. I name this part of the ilio-crural stratum, '*gluteo rectus,*' believing it to represent the *gluteus maximus* (if there is any representative of that muscle in Urodelans) and the *rectus femoris* of mammals.

The outer sector (Fig. 2, *B*) arises from the ilium just beneath the preceding, and so close to it that it may almost be said to arise by a common tendon with it; it descends along the fibular side of the thigh and terminates in a broad tendon which, insinuating itself between the peroneus muscle and the fibula, is inserted into the upper third of the shaft of that bone. The peroneal nerve (Fig. 10, *P*) crossing beneath it, runs along its upper edge to the dorsum of the leg. The relation of the nerve, as well as the insertion of the muscle, indicate this outer or ilio-fibular sector to be the *biceps flexor cruris;* and it affords an example, not uncommon, of a muscle which belongs to the dorsal or extensor series becoming, by virtue of its position upon the side of a joint, an adjunct in its action to the plantar or flexor group. It is accompanied, in the distal part of its course, by a distinct spindle-shaped muscle (Fig. 10, *F*, *f*), which arises, by a tendon, from the plantar aspect of the femur, just beneath the insertion of the tendon of the caudo-femoral, and is inserted tendinous into the middle third of the shaft of the fibula beneath the tendon of the biceps. This femoro-fibular muscle appears to represent the short or femoral origin of the *biceps.*

The DEEPER OR ILIO-FEMORAL STRATUM of the DORSAL mass covers the iliac part of the hip-joint. It arises from the outer and anterior surface of the ilium near the joint, between the *pectineus* anteriorly and internally and the *ischio-femoral* posteriorly and externally, being separated from the former by the origin of the *internal rectus* and from the *ischio-femoral* by the sciatic nerve. It moreover extends a little upon the internal surface of the ilium, and still further upon the adjacent internal surface of the ischium, where it reaches behind the *pectineus* as far as the middle line. It is inserted into the fibular side of the middle of the *linea aspera*, close to the *caudo-femoral* and the *femoro-fibular* and close to the adductors, which are inserted into the tibial side of that line. Its attachment extends also from the linea aspera upon the fibular side of the plantar surface of the femur. Its origin from the ilium extends on either side of, or rather, in front and behind the origin of the *gluteo-rectus* and *biceps:* and the part in front of those muscles, lying upon the front of the hip and the ilium, appears to correspond with the *iliacus internus*, while the part lying behind those muscles and lying upon the back of the hip and the ilium appears to correspond with the lesser *glutei* and the *pyriformis*.

It must be remarked that the ilium is chiefly occupied by the attachments of the caudal and abdominal muscles—the internal oblique more particularly—and little space is left for the glutei. They are accordingly almost abortive. The *gluteus maximus* is absent, unless it is, as I have supposed probable, blended in the part of the ilio-crural section which I call *gluteo-rectus;* and the other *glutei* are very small; and in order to gain sufficient space for attachment they extend upon the inner surface of the ilium, and still more upon that of the ischium, thus spreading beyond their proper area and encroaching upon the territory appertaining to the plantar muscles, more particularly occupying the ground from which the internal obturator usually arises. This, at least, I suppose to be the case. It must however be stated that the muscles immediately surrounding a ball-and-socket joint in such an animal as the Cryptobranch somewhat resemble the capsule of the joint itself in the mode in which they invest it, and in the imperfection of their segmentation; so that the division into separate muscles is rather arbitrary, and the nomenclature proportionately uncertain.

It will have been remarked that the deeper parts of the extensor cruris, viz. the *vasti* and *crureus*, which are such constant elements in higher animals, do not exist in the Cryptobranch, and the lower space of the femur usually devoted to their origin is occupied by the insertion of the *pectineus*, while the upper part does not give attachment to any muscle.

The dorsal aspect of the thigh is covered by areolar or fascial tissue in addition to the muscles above enumerated; and this is an extension of or is continuous with the hinder portion of the external oblique between the ala of the ilium and the spine of the pubes.

PLANTAR MUSCLES OF LEG AND FOOT.

Below the knee the plantar aspect of the limb is occupied by a broad thick pronato-flexor mass, extending from the femur to the ends of the toes, and with some difficulty distinguishable into parts—strata and sectors. It arises from the plantar surface of the fibular side of the limb, namely, from the fibular condyle of the femur, from the fibula in its whole length and the fibular side of the tarsus, being continuous with the *abductor minini digiti.* Superficially, it is blended with the *caudo-pedal,* extends over the sole and divides into five tendons, which pass to the terminal phalanges of the five digits. Detachments from the deeper surfaces of these tendons pass to the first and second phalanges; and still deeper parts of the muscle are inserted into, as well as arise from, the proximal and distal row of tarsal bones and the metatarsals. The chief direction of the fibres is from the fibular towards the tibial side of the limb as well as downwards. Near the surface the fibres are nearly vertical and have, in the main, a flexor action. Traced more deeply they are, for the most part, more oblique; and the deepest of all are transverse and act simply as pronators.

The mass is partially divided into a SUPERFICIAL and a DEEP STRATUM, with the chief nerves of the back of the leg and sole running between them. The two strata are however blended together above and still more below.

The SUPERFICIAL STRATUM (Figs. 10 and 11), which is the part blended with the caudo-pedal, extends from the fibular condyle and the fibula to the ends of the digits. Its fibres have in the main a vertical direction, and exercise in the main a flexor function. It corresponds apparently with the *gastrocnemius, soleus* and *plantar fascia,* and with the *plantaris* and *flexor brevis digitorum* (the last two should be regarded as one, forming a *flexor sublimis digitorum*[1]). I will recur to the disposition of its divisions in the digits after describing the *flexor profundus.*

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[1] The terms '*sublimis*' and '*profundus*' are greatly to be preferred to '*brevis*' and '*longus*' in designating these flexor muscles of the digits; because,

The DEEP STRATUM is disposed in an interesting manner. Its fibres are more oblique and have more of a pronator function than those of the superficial stratum. It is composed, *first* and chiefly, of a mass of fibres (Fig. 11, *Pr. p*) derived, slightly, from the fibular condyle of the femur in conjunction with those of the superficial stratum, but, chiefly, from the fibula and the fibular part of the tarsus—the two fibular tarsal bones—and slightly from the adjacent tarsal bones. They are directed downwards and inwards to the distal row of tarsal bones, to the metatarsal of digit I. and slightly to the metatarsals of II. and III., and also join the deeper surface of those divisions of the superficial stratum which pass to the flexor tendons of digits I. II. and III. This mass may be called '*pronator pedis*'[1]: it appears to combine the representatives of the *tibialis posticus* and those portions of the *flexor digitorum profundus* which we call the *flexor longus pollicis* and the *accessorius.*

A *second* part of the DEEP STRATUM (Fig. 11, *Fl. pr.*) still lying beneath the nerves is a long, thin muscle, quite separate in its upper part, which arises from the upper end of the fibula, descends upon the main mass of the deep stratum (the *pronator pedis*), the fibres of which cross obliquely from the fibula beneath it. Having reached the tarsus it expands, trumpet-like, beneath it and divides into five muscular bundles to the five digits. I have said that it lies, in the leg and in the proximal part of the tarsus, superficial to the *pronator pedis;* but its insertion into the digits is deeper; and in order to reach this deeper plane it, or rather the part of it destined to digits I. II. and III., curls round the fibular edge of the part of the *pronator pedis* passing to the *flexor sublimis,* so as to come into

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in conjunction with the *plantaris,* which is really the upper or crural part of it, the *flexor sublimis* (*brevis* usually termed in man) is quite as long or longer than the *flexor profundus;* and the relation of the *flexor sublimis* to the *plantaris* —a cardinal point in the anatomy of the muscles of the leg illustrated in most mammals—is ignored or rather concealed by the term '*brevis*' of human anatomists.

[1] I call the muscle '*pronator pedis*' to facilitate subsequent descriptions, and because the name indicates an important part of its function; but even in this animal it has a flexor action, especially the fibres of it joining the *flexor sublimis,* and its representatives in the higher animals, in which pronation and supination of the foot do not take place, have a flexor action only.

close proximity with the tarsus. As it expands beneath the distal row of tarsal cartilages to reach the digits on the tibial side, it crosses the insertion of the *pronator pedis* into those cartilages, and itself acquires a connection with the cartilages, sending some fibres to them and deriving some fibres from them, and some of its fibres are here blended with those of the *pronator pedis.*

In Menopoma (Fig. 13) the interruption by the projecting tarsal cartilage is more complete than in Cryptobranch; so that the long band descending the leg is inserted there, or nearly so, and short muscles to the digits take their origin there. It seems not improbable that the *flexor profundus* is compounded of detachments from short flexor muscles arising from the tarsus with a detachment from the *pronator pedis* inserted into the tarsus; and may it not be that the fibrous mass, or sesamoid ossicle so commonly found in the tendon of this flexor and in its homologue of the fore limb, is a representative of the skeletal structure which in these animals intervenes between the upper and the lower parts of the muscle, and which becomes detached with the muscular fibres when the continuity of the two parts of the muscle is established?

Further, are not sesamoid ossicles in other parts similar detachments from the bones near which they lie?

Each of its five digital bundles subdivides into three, a middle and somewhat superficial part which is inserted into the base of the proximal phalanx, and two lateral parts which are attached to the sides of the metacarpal. The subdivision, which passes to the fibular side of met. v. is thin; and the division which passes to the pollex subdivides only into two, one to the middle and the other to the fibular side of the proximal phalanx. This muscle represents in the main that portion of the *flexor digitorum* which we usually call the *flexor longus digitorum.* I say in the main, because the representatives of the two parts of this stratum, which I have designated *pronator pedis* and *flexor profundus digitorum,* are, in other animals, variously blended to make up the *flexor hallucis, flexor longus digitorum,* and the *accessorius.*

The arrangement of each of the divisions of the *flexor subl. digitorum* resembles generally that of the divisions of the *flexor profundus digitorum* just described. Each (Fig. 11, *a*) subdivides into three, of which the two lateral pass to the sides of the approximated ends of the metacarpal bone and the proximal phalanx, while the middle portion passes on to the second or terminal phalanx. That at least is the case in digits I. II. and V., which have only two phalanges. In digits III. and IV., which have three phalanges, the middle portion again subdivides into three, of which the lateral parts are attached to the sides of the penultimate phalanges, while the middle parts go onwards to be inserted into the terminal phalanges. So that digits I. II. and V. have the same complement of muscles as III. and IV., but the second tripartite division does not take place in them.

There are in the individual digits some exceptions to this arrangement which should be mentioned. Thus, in digit I. the tendon sends only one offset to the middle of the proximal phalanx, and then passes on to the terminal phalanx. In III. the penultimate phalanx is treated like the proximal in I. receiving only one offset to its middle from the tendon on its way to the terminal phalanx. In V. the tendon detaches the usual lateral offsets to the approximated ends of the metacarpal and the proximal phalanx, and subsequently detaches an offset to the middle of the same phalanx before its insertion into the base of the terminal phalanx.

These points are deserving of special notice, because the lateral offsets are probably the representatives of the *lumbricales*, and the median offsets are probably the representatives of the *retinacula* not unfrequently found in Mammals, and usually observable in connection with flexor tendons of the toes in Birds.

The *third* part of the DEEP STRATUM (Fig. 14, *Pr. t.*) lies beneath, deeper than, the others, and is separate from them and composed of fibres still more obliquely, indeed almost transversely, directed. They form a square muscle, passing from the shaft of the fibula across the interosseous space to the shaft of the tibia. It may be called '*pronator tibiæ.*' The upper fibres[1] have a slight inclination from the fibula downwards, while the lower fibres have a slight inclination upwards, crossing behind the upper.

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[1] Some of the uppermost fibres are attached quite to the top of the fibula. In Scinc the upper part, slightly separate from the rest, arises by a tendon from a sesamoid behind the knee common to it with the descending tendon of the caudo-femoral and the two strata of the flexor mass; and through the medium of this sesamoid and the fibrous bands that unite it with the condyle, the upper part of the *pronator tibiæ* derives its origin from the fibular condyle, and corresponds with the *popliteus* of mammals.

Tarso-metatarsales (Fig. 12) are a series of short thick muscles passing from the under surface of the distal row of tarsal bones to the under surface of the metatarsals near the base. Each, like the flexors of the digits, divides into three, but the lateral portions are rather more prolonged upon the metatarsals than are the middle portions. In digit I. the middle portion is wanting, and the laterals are very delicate In digit V. the division into three parts is scarcely to be made out.

Metacarpo-phalangei (Fig. 12) arise from the under surface of the metacarpals near the insertion of the middle portions of the tarso-metatarsals, and in some instances are continuous with them. They are present in all the digits, and are inserted into the bases of the proximal phalanges, close to, and blended with, the tendons of the *flexor digitorum longus* inserted at the same parts.

Phalangei (Fig. 12) are present only in digits III. and IV. (the digits with three phalanges). They arise from the under surface of the proximal phalanges, and are inserted into the bases of the second phalanges blending with the parts of the tendons of the *flexor digitorum sublimis* which are attached here. There is a slight thickening in the tendons as they pass under the joints suggestive of a sesamoid body.

In higher animals the *phalangei* are absent, and the *interossei* (p. 30), the *tarso-metatarsales*, and the *metatarso-phalangei* are blended in the *short flexors* and *interossei*.

Adductor minimi digiti is a piece of the flexor mass extending from the lower end of the fibula to the fibular side of the tarsus and the base of met. V.

DORSAL MUSCLES OF LEG AND FOOT.

The muscles on the dorsal aspect of the leg and foot form a supinato-extensor mass corresponding antagonistically with the pronato-flexor mass on the plantar aspect, and, like it, consisting of a superficial and a deep stratum. There is however a less amount of muscular substance, and less complexity in its disposition and subdivision.

The SUPERFICIAL STRATUM arises by one broad tendon from the dorsal surface of the fibular condyle of the femur. It soon divides into three parts or sectors—a 'tibial,' a 'fibular,' and an 'intermediate.'

The tibial sector—*tibialis anticus* (Fig. 15, *T. a.*)—is inserted along nearly the whole of the fore part of the tibia. Its more superficial fibres extend over the ankle, and are inserted into the dorsal surface of the proximal tarsal bone on the tibial side.

The deeper fibres of the intermediate sector—*extensor longus digitorum* (Fig. 15, *E. d.*)—are united to and inserted with those of the preceding into the tibia. The more superficial portion divides over the ankle into five broad tendons which reach the terminal phalanges of the five digits, and send down detachments from their deeper surface to the proximal phalanges. Moreover at each notch between the divisions into the five tendons a process passes into the interval between the subjacent metacarpals, and bifurcating extends a short distance along their contiguous sides and is inserted into them, so that traction of the muscle has the effect of approximating the digits.

A delicate detachment (Fig. 15, *E. d'.*) from the fibular side of the muscle in close apposition to a similar detachment from the fibular sector, forming a *peroneus tertius*, is inserted into the proximal tarsal bone on the fibular side.

The outer or fibular sector—*peroneus*—is inserted into the fibula in nearly its whole length, with the exception of the slip just mentioned, which contributes to form the *peroneus tertius*. This muscle is therefore, in the Cryptobranch, derived from both the *peroneus* and the *extensor digitorum*. Some few of the fibres of the *peroneus*, it should be added, extend over the end of the fibula, and are continuous with the fibres of the *abductor minimi digiti*.

The DEEP STRATUM exists as a separate layer only at the lower part of the leg and on the foot. It consists of two parts.

(1) *Supinator pedis* (Fig. 15, *S. p.*), a narrow band which arises from the dorsal surface of the lower end of the fibula, and crosses the ankle and tarsus obliquely to the base of the tibial side of the metatarsal bone of digit II. (Digit I. is absent in the hind limb.)

(2) *Extensor brevis digitorum* arises from the dorsal surface of the tarsus, more particularly on the fibular side, and is inserted into the under surface of the extensor tendons as they pass over the digits. A slip detaches itself from the tibial side of this muscle and joins the supinator pedis.

Interossei metacarpales occupy the proximal parts of the intervals between the metacarpals, passing nearly transversely between the adjacent sides of the several bones. Their free edges are defined and curved or semilunar, the fibres descending a little along the sides of the metacarpals, but they do not reach the phalanges.

MUSCLES OF THE FORE LIMB.

The fibro-cellular or fascial tissue which covers the dorsal muscles and extends upon the ventral muscles and upon the head is thicker over the dorsal muscles than elsewhere, and is especially thick near the head. It here furnishes attachment or origin to muscles passing upon the scapula and the throat.

There are four muscular sheets thus arising placed beneath one another and distinct from each other. The most superficial (*subcutaneus colli*, Fig. 5, *S. c. C.*), the thinnest and least defined, is a cutaneous muscle the representative of the *panniculus carnosus* and the *platysma myoides*. Behind, it reaches as far as the *latissimus dorsi*. Anteriorly and ventrally it meets its fellow in the middle line, and is attached along the inner side of the edge of the lower jaw. Near the angle of the jaw its deeper surface is joined by the fibres of the myho-hyoid radiating above it. Under the *subcutaneus colli* is the *depressor mandibulæ* and then the *constrictor faucium*.

The deepest is the *trapezius* (Fig. 6, *Tr.*), which arises from the fascia covering the dorsal muscle opposite the scapula and as far forward as the skull, also from the occipital bone above the insertion of the dorsal muscle, and round the side of that insertion from the lateral part of the occipital. This last part of its origin is very deep, reaching with the lateral septum to the base of the skull, and probably represents the *cervico-humeral* of certain mammals. The fibres converge to be inserted into the anterior edge of the scapula, the upper edge of the precoracoid, and the retiring angle beween the scapula and the precoracoid.

Levator scapulæ (Fig. 6, *L. sc.*) is a long narrow muscle arising by a delicate tendon from the base of the skull close to the insertion of the subvertebral rectus, indeed looking like a derivation from it, and inserted into the middle of the outer surface of the suprascapula above the origin of the *dorsalis scapulæ.*

It arises from the skull in this animal and the other Urodelans probably, because of the proximity of the scapula to the head. It is a very definite muscle in them, and attached only to and near the angle of the scapula. In Saurians, where the clavicle reaches this angle, the muscle creeps upon it forming a *levator claviculæ;* and rudiments of the same are sometimes met with in Man and other mammals.

Serratus magnus (Fig. 4, *S.*) arises by two bundles from the fore parts of the ends of the second and third ribs, the two foremost origins of the external oblique being from the hinder parts of the ends of those ribs. It is inserted into the under surface of the upper and also of the anterior part of the supra-scapula.

The *omo-hyoid* (Fig. 5, *O. h.*) passes from the anterior edge of the scapula beneath the *trapezius* to the side of the ventral muscle advancing forwards to the hyoid, with which it is blended[1].

These are the four muscles which pass from the trunk to the scapula.

The muscles of the fore limb, like those of the hind limb, may be classed as flexor or 'palmar,' and extensor or 'dorsal;' and, after the manner of the hind limb, of those which pass from the shoulder-girdle to the limb, the palmar muscles take their origin from the coracoids, or subglenoid part of the girdle, and the dorsal muscles arise from the scapular or supraglenoid part of the girdle. Here, however, as in the hind limb, the muscles are not bound within rigid barriers, functional or territorial, but may be found to stray or glide more less across their frontier lines into other districts, and sometimes pass from an extensor to a flexor office.

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[1] In Menobranch the long precoracoid cartilage lies upon the omo-hyoid, and this muscle as it passes back beneath it divides into two, one portion going over the anterior, and the other over the posterior, edge of the base of the precoracoid to its outer surface, where they are inserted.

On the Palmar Aspect of the Girdle and Arm.

The *pectoral* (Fig. 5, *P.*) is derived almost entirely from the superficial stratum of the obliquo-rectus of the abdomen, and is continuous with it. Where the fibres diverge from the trunk-muscle and take their independent course over the coracoid and to the humerus, they lose the tendinous inscriptions, *i.e.* in the last four inches of their course. A few fibres are derived from the sternum; and as the muscle passes over the hinder part of the coracoid it acquires some addition from muscular fibres which arise from the coracoid. It is inserted into the radial edge of the radial tubercle near the upper end of the humerus, none of the fibres extending beyond this tubercle. Its anterior edge is continuous with fascial tissue superficial to the precoracoid and extending over the neck[1].

The coracoid and precoracoid cartilages in this animal are very large and form a considerable part of the glenoid cup; and the muscles arising from them are numerous, almost surround the head of humerus, and are difficult of interpretation. They arise chiefly from the outer surface or the edge, and are as follows.

1. A broad thin muscle, arising from the outer surface of the sternal or epicoracoid edge of the coracoid superficial to the *biceps*. It crosses the muscular fibres of the *biceps* superficially and transversely and converges to be inserted into the summit of the upper part of the radial tubercle of the humerus, just above the pectoral. It may be called *epicoraco-humeral* (Fig. 17)[2]. Some of its superficial fibres are blended with those of the under surface of the pectoral, and it is not improbably the representative of the *pectoralis minor* of mammals.

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[1] This is the fascial investment already spoken of (p. 2) as covering the body. Schmidt, Goddard, and van der Hoeven, speak of the connection of the pectoral with the sternum and coracoid, but do not mention its relation to the external oblique, or to the fascial tissue.

[2] It corresponds, I think, with that described under this name in the Echidna, by Mivart. *Trans. Linn. Soc.* xxv. 388.

2. *Precoraco-brachial* (Fig. 17, *P. c. b.*), arises from the whole of the outer surface of the precoracoid cartilage, with the exception of the marginal part. It lies in the same plane with the *epicoraco-humeral*, indeed is almost continuous with it, and is inserted, in close connection with it and with the pectoral, into the radial side of the uppermost part of the radial tubercle of the humerus[1].

3. *Coraco-brachialis longus* (Figs. 17 and 18, *C. b. l.*) is the largest of the muscles arising from the coracoid. It arises from the hinder edge of the coracoid and divides into two portions. Of these, the larger and inner or lower division is inserted into the ulnar edge of the humerus for a quarter of an inch above the internal condyle: the other division, being nearly as large, is partly inserted into the side of the long tendon of the biceps, while a bundle of its fibres is continued on over the elbow, and is inserted into the ulna near the joint.

This last-described division must represent the short or coracoid origin of the biceps in Man. There is no trace of it in Menobranch Axolotl or Newt. The muscle in them though large is confined to the humerus in its insertion.

4. *Coraco-brachialis brevis* (Fig. 17, *C. b. br.*) arises from the coracoid close to the shoulder-joint, between the preceding muscle and the joint, and also from the external surface of the hinder part of the coracoid near the joint. It passes beneath the *biceps* to the ulnar side of the humerus near the shoulder-joint, and to the base of the ulnar side of the radial tubercle of the humerus beneath the *coraco-brachialis superficialis*. It corresponds with the ordinary mammalian coraco-brachial.

The median nerve passes between these last two; while the ulnar vessel, and in animals where it is present the ulnar nerve also, continues its course behind both.

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[1] This muscle is called *subclavius* by Mivart, in his description of Menopoma and Menobranch, *Proc. Zool. Soc.* 1869, pp. 265 and 460, though he regards it as the same as that named by him *epicoraco-humeral* in the Echidna. The relations of the muscle to the mammalian *subclavius* do not appear to be sufficiently clear to induce me to follow in the application of that name to it; and it arises from the precoracoid rather than from the epicoracoid part of the girdle. In Menobranch it is inserted into the summit of the radial tubercle, and its under surface is blended with the supra-scapular which makes its appearance in that animal though quite absent in Cryptobranch.

5. *Coraco-brachialis quartus* (*subscapularis*) arises from the margin of the coracoid and also of the scapula forming the inner edge of the glenoid cup, extending from the origin of the *coraco-brachialis brevis* to and over that of the triceps and also a very short distance upon the adjacent inner surface of the scapula. It separates the origin of the *coraco-olecranalis* from the capsule and from the origin of the *triceps*. The latter expands somewhat into the capsule, and so separates this muscle behind from the capsule. With that exception it is in immediate contact with the capsule which is thin under it. It is inserted into the upper part of the humerus behind the preceding, that is, just behind the ulnar edge between the *coraco-brachialis brevis* and the inner or third origin of the triceps. Indeed some of its fibres are continous with the former of those muscles in front, and with the latter behind.

This muscle spreading itself to a greater extent upon the internal surface of the scapula in some animals becomes the subscapular. It is called subscapular by Mivart in Menopoma and Menobranch. In the latter animal its extension upon the inner surface of the scapula is rather more decided than in Cryptobranch.

6. *Coraco-olecranalis* arises, by a tendinous band, from the edge of the coracoid, near the joint, internal to the middle of the preceding muscle, which separates it from the joint. It soon becomes muscular, descends the ulnar side of the arm dorsally, joins the triceps and is inserted with it into the inner side of the olecranon.

This coracoid accession to the *triceps* is common in Reptiles as well as in Urodelans. It results from the large relative size of the coracoid, and reminds us of the accession which the *quadriceps extensor cruris* in these animals receives in the form of what I have called *internal rectus* from the inner side of the front of the hip-joint. Only, in consequence of the difference in the rotation of the two limbs, the extensor of the forearm being directed backwards, gains its accession from the back of the shoulder-girdle, while the extensor of the leg being turned forwards gains its accession from the front of the pelvic girdle.

The *coraco-olecranalis* is also an example of the deviation of a member of the flexor series to an extensor function : just as the *biceps flexor cruris* is an instance of the deviation of a member of the extensor series to the flexor function, the office in each instance being determined by the position and attachment.

7. *Coraco-radialis*, or *biceps* (Fig. 17, *B*.), arises from the

external surface of the coracoid, between the epicoraco-brachial (*pect. minor*) and the short coraco-brachial, as a fan-shaped muscle, the fibres of which pass across the short coraco-brachial and soon converge into a long tendon, which runs down beneath the pectoral. Having passed the pectoral it receives the fibres of the long coraco-brachial, passes over the elbow-joint, and is inserted into the palmar surface of the upper end of the radius close to the joint. It is supplied by the nerve which perforates the scapula and which supplies also the superficial coraco-brachial.

I find the *biceps* corresponding with the above and distinct from the *brachialis anticus* in Menobranch, Newt, and Axolotl. In the Newt the long thin tendon is more closely related to the *brachialis anticus*, but does not seem to derive muscular fibres from it. As above mentioned, it does not in any of these animals derive fibres from the *coraco-brachialis longus*.

The *Brachialis anticus* arises from the radial side of the radial tubercle of the humerus, close, but on the opposite side of the tubercle, to the insertion of the pectoral, and beneath the insertion of the *dorsalis scapulæ*[1]. It passes along the shaft of the humerus, deriving no fibres from it, passes over the elbow superficial to the *biceps* tendon, and is inserted about equally into the radius and ulna. Its foremost fibres are inserted into the ulnar side of the radius at a short distance from the joint, nearly in the situation corresponding with the middle of the insertion of the supinator longus in ourselves. Its hinder half, passing between this radial insertion and the insertion of the *biceps*, is attached to the adjacent palmar surface of the ulna.

ON THE DORSAL ASPECT OF THE GIRDLE AND ARM.

The *trapezius* already described, (p. 30).

Latissimus dorsi arises from the fascial tissue over the dorsal muscle, extending, forwards, nearly to the head, overlying the hinder part of the trapezius and, backwards, half way to the pelvis. It is a thin muscle and its edge is not very defined in front or behind. The fibres converge and are blended with the upper part of the scapular origin of the *triceps*. Through the medium of it some are connected with the hinder margin of the scapula near the glenoid cavity; but it has no direct attachment to the scapula, and we cannot trace any of its fibres to the humerus.

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[1] I may observe that neither in this nor in the hind limb is the surface for attachment of muscles increased by intermuscular septa extending from the sides of the humerus and femur.

In these animals, in Reptiles and Birds, the *lat. d.* overlaps the *trapezius;* the reverse being the case in mammals.

Dorsalis scapulæ (Fig. 17, *D. s.*) arises from the outer expanded surface of the supra-scapula. It is a long trumpet-shaped muscle, and is inserted into the radial side of the radial tubercle of the humerus beneath the insertion of the *pre-coraco-brachial*.

This is in Cryptobranch the only muscle, with the exception of the few fibres of the *subscapularis* above mentioned, passing from the scapula to the humerus. In Menobranch there is in addition a muscle, blended with the deeper part of the precoraco-brachial, which represents the *supra-scapular*. The *dorsalis scapulæ* must represent, in the main, the *infra-spinatus*. Its superficial part, probably, becomes in other animals developed so as to contribute to the scapular part of the *deltoid*, and its hinder part is segmented as the *teres minor*. The *clavicular* part of the *deltoid* corresponds probably, to some extent, with the superficial fibres of the *precoraco-brachial*. Thus the clavicular and scapular parts of the deltoid come into relation with the *trapezius*, which is, in Urodelans, inserted into both precoracoid and scapula. They overlie the *supra-* and *infra-spinatus* and *teres minor* muscles, and have insertion corresponding with that of the *pre-coraco-brachial* and *dorsalis scapulæ*. The two parts are not uncommonly separate.

The few fibres of the *subscapularis* constitute the only appearance of muscle upon the whole of the large extent of the concave under surface of the coracoids and scapula, so that the surface is free to play upon the convex outer surface of the ventral muscle on which it lies.

Triceps arises by a tendon from the posterior edge of the scapula, immediately behind the joint and in close connection with the capsule, which indeed it strengthens by expanding upon it. It soon becomes muscular and is joined by the *latissimus dorsi*. A second head arises from the radial side of the humerus at the base of the tubercle, and a third from the hinder and ulnar aspect of the humerus. These all unite; and the muscle is inserted into the olecranon, being joined by the *coraco-olecranalis*.

PALMAR MUSCLES OF FOREARM AND HAND[1].

On the palmar aspect of the forearm the muscles form, as on the plantar aspect of the leg, a pronato-flexor mass, which is partially divided into two strata.

The SUPERFICIAL STRATUM (Fig. 18) is in three sectors. A radial sector representing the *Pronator teres* and the *Flexor carpi radialis*, large and thick, passes from the anterior or palmar part of the ulnar condyle, commencing close to the joint and extending a little way up the humerus above the condyle, crosses the forearm obliquely, and is inserted into an oblique line on the radius, which passes across its palmar surface from the ulnar to the radial edge, and into the radial edge as far as the wrist, also into the radial side of the two radial cartilages of the wrist. The upper edge of its insertion is immediately below that of the *brachialis anticus*. The deepest portion of the muscle, arising from the condyle close to the joint and passing to the ulnar edge of the radius, that is, to the upper part of the oblique line just mentioned, is in close contact with the *pronator quadratus* and at its insertion is blended with it, but is separated from it nearer the origin by the nerve (ulnar nerve) passing from the median nerve to the ulnar side of the forearm. This deepest portion of the muscle, which obviously corresponds with the ulnar origin of the *pronator teres* in man, is slightly separated from the rest by the branch of the median to the *flexor digitorum sublimis*[2] (see Fig. 18).

Flexor digitorum sublimis (Fig. 18, *Fl. d. s.*) forms the middle sector. It arises from the inner part of the ulnar condyle of the humerus, covering the preceding sector at this part. It soon lies on the same plane with it, occupies the middle of the forearm and receives an accession in the form of a portion arising by a flat tendon from the middle of the ulna (Fig. 19, *Fl. d. s.*) on the radial side of the *flexor carpi ulnaris*. The fibres of this portion join the under surface of the ulnar side of the general mass. It terminates over the carpus in a broad tendon, which is joined by a portion of the deep stratum, and divides into four tendons to the four[1] terminal phalanges. The disposition of the tendons corresponds almost precisely with that of its homologue in the hind limb (p. 26). Each subdivides into three, two lateral and a middle, the two lateral pass to the sides of the approximated ends of the metacarpal and the proximal phalanx, while the middle portion passes on to the second or terminal phalanx. In digit IV., which has three phalanges, the middle portion again subdivides into two, of which the deeper is attached to the base of the second phalanx, while the superficial runs on to the terminal phalanx.

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[1] I apply the term 'hand' to the distal segment of the fore limb simply for the convenience of distinguishing it from the distal segment of the hind limb.

[2] In the Scinc this portion, similarly related to the nerve and arising from the condyle beneath the rest of the muscle, is quite separate in its whole length, forming a *pronator intermedius*, and, serially, corresponding precisely with the *popliteus* in ourselves.

Flexor carpi ulnaris (Fig. 18, *Fl. c. u.*) arises from the inner condyle in conjunction with the *flexor digitorum*, and is inserted along the lower two-thirds of the ulna and into the proximal ulnar carpal bone; and some of its fibres are continued into the *abductor minimi digiti* which extends along the side of the metacarpus to the ulnar side of digit V.

The DEEP STRATUM arises from the plantar surface of the ulna commencing a little below the elbow-joint, also from the cartilages forming the middle or radial part of the carpus, but not those quite on the radial side. The fibres pass partly into the under surface of the radial part of the *flexor sublimis digitorum* and, partly, to the metacarpal and to the distal carpal bone on the radial side, also to the ulnar edge of the radius.

More accurately described the arrangement of the components of this stratum is as follows in three parts—*Pronator radii quadratus*, *Pronator manûs*, and *Flexor profundus digitorum.*

1. *Pronator radii quadratus* (Fig. 18, *Pr. q.*) arises from the upper part of the palmar surface of the ulna near the radial edge, and is inserted along the ulnar edge of the radius, its uppermost fibres blending at their insertion with the deepest fibres of the superficial layer (*pronator teres*). The upper fibres have some obliquity downwards from the ulna to the radius, the lower fibres are more transverse, and rather behind the upper.

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[1] Of the four digits in this limb digit IV. only has three phalanges, the remaing digits II. III. and V. having each but two phalanges.

The position of the muscle on the same level with the next portion of the deep layer indicates, as does the passage of the large branch of the median behind it, that it is a segment from the deep stratum rather than a third and hinder stratum which one might at first be disposed to regard it, and which view the position of its correspondent in the hind limb rather favours. By the connection of the muscle with the lower part of the *pronator teres* a continuity between the two muscles and between the two strata is established above. It is not so large, does not descend so low as its correspondent in the hind limb, and it is not placed behind the plane of the deep flexor stratum as the *pronator tibiæ* is in that limb. The difference in the last particular is caused by the greater size of the *pronator tibiæ* as well of the deep flexor stratum in the hind limb, so that the one comes to overlie the other.

2. The largest portion of the deep stratum, which I will call '*pronator manûs*' (Figs. 18 and 19, *Pr. m.*), arises from the radial side of the palmar surface of the ulna, beneath the preceding, and from the middle carpal cartilages. Its superficial fibres run into the radial part of the under surface of the *flexor sublimis*, just as the fibres from the ulnar origin of that muscle run into the ulnar part of its under surface. Its deeper fibres are inserted into the distal radial carpal bone and the base of the metacarpal of II. and III.

3. The *flexor profundus digitorum* (Figs. 18 and 19) is a flat band arising from the upper part of the palmar surface of the ulna between the *pronator quadratus* and the *flexor carpi ulnaris*. Like the corresponding band in the hind limb, it is completely segmented from the other muscles, and descends vertically. It passes deep, is connected with the distal carpal cartilage near the base of digit IV. detaching some fibres to the cartilage, and acquiring some from it; indeed the cartilage projects up through the muscle. The muscle now spreads out fan-like, and sends a division to each of the four digits. Each division is inserted chiefly into the base of the proximal phalanx, and a lateral detachment passes to one or both sides of the metacarpal. The division which passes to digit II. encounters another distal carpal cartilage, which also projects up through it, some of the muscular fibres passing to the cartilage and some passing from it. This trumpet-like muscle does not, as in the hinder limb to so great an extent, curl beneath the level of the pronator portion of the stratum (the *pronator manûs*),

because that portion is in the fore limb smaller, not arising from the ulnar part of the carpus; and the trumpet-like part of the *flexor profundus digitorum* is more on the same level with it, and lies on its ulnar and distal sides. Still the portion to digits II. and III. does, as in the hind limb, curl beneath the superficial fibres of the *pronator manûs* which pass into the under surface of the *flexor sublimis* going to those digits.

The short muscles resemble those in the hind limb (p. 28).

Carpo-metacarpales pass from the distal row of the carpals, each to the sides and middle part of its metacarpal. The middle are shorter than the lateral fibres, to give space for the

Metacarpo-phalangei which pass from the middle of the palmar surface of the metacarpals to the bases of the proximal phalanges.

Phalangeus is present only in digit IV. passing from the proximal to the second phalanx.

DORSAL MUSCLES OF FOREARM AND FOOT.

On the dorsal aspect of the forearm and hand the muscles form a 'supinato-extensor' mass, corresponding, serially, with the 'supinato-extensor' mass in the leg and foot, and, antagonistically, with the 'pronato-flexor' mass in the leg and foot, and in the forearm and hand. Like those, they are partially divisible into a superficial and a deep stratum.

The SUPERFICIAL STRATUM arising from the dorsal surface of the radial condyle and the adjacent part of the humerus, preponderates over the deep stratum more than is the case on the palmar aspect, It is in three sectors, a 'radial,' an 'ulnar,' and an 'intermediate.'

The radial sector representing the *supinator longus* and *brevis* and the *extensores carpi radiales* is the largest. It arises from nearly the whole of the part of the humerus mentioned, and is inserted into the whole of the dorsal surface of the radius. A portion of its fore part extends over the wrist-joint and carpus, and is inserted into the ulnar side of the base of met. II. representing the extensor *carpi radialis longior*[1] (Fig. 17, *Ext.*

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[1] In Menobranch it runs on to the radial carpal bone, but not to the metacarpus.

c. r.). The upper and deep part, which might be regarded as appertaining to the deep stratum, represents the *supinator brevis* and the part lying between these two, and inserted into the radius nearer the wrist, represents the *supinator radii longus* (Fig. 17).

The middle sector (*extensor digitorum sublimis*) arises from the humerus, superficially to the radial sector. Passing down the forearm and over the carpus, and receiving upon its under surface fibres from the *extensor digitorum brevis*, it divides to the four digits, passing to the terminal phalanges[1].

The ulnar sector (*extensor carpi ulnaris*) arises on the ulnar side of the other sectors, is inserted into nearly the whole of the shaft of the ulna, and a portion runs on to the ulnar side of the carpus.

The greater proportion of the fibres therefore pass from the humerus to the ulna instead of, as in most higher animals, from the ulna to the carpus. A similar deviation from the disposition in higher animals also is presented to a still greater extent by the corresponding stratum in the hind limb, the fibres of which pass largely from the femur to the tibia and fibula, instead of as in Man all passing from the leg to the foot.

The DEEP STRATUM is absent from the upper region of the forearm, except the part of it blended with and forming the deeper portion of the radial sector just described as representing the *supinator brevis*.

The uppermost part of the deep stratum, with that exception, arises from the dorsal surface of the lower end of the ulna, and crossing over the back of the radius and the carpus and the *extensor carpi radialis*, is inserted into the radial side of the base of met. II. It represents the *extensor poll. primus*. It may be best called '*Supinator manûs*' (Fig. 17, *Sup. m.*).

This is a better term than that of '*rotator carpi*' which I applied to the same muscle (*Journal of Anat.* IV. 48). It is one of the most constant muscles in the forearm, is the serial homologue of the muscle which I have called *supinator pedis* (p. 29), and, like it, is in the same plane with and in a higher level than the extensor brevis and often connected with it.

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[1] In Menobranch and in Saurians it stops, like its homologue in the hind limb of those animals and of Aï, at the metacarpus, being inserted there in three portions; and small muscles arising from the metacarpus, close to its insertions, constitute the only extensors of the digits, and pass to the terminal phalanges.

frontier lines into other districts, and sometimes pass from an extensor to a flexor office.

On the Palmar Aspect of the Girdle and Arm.

The *pectoral* (Fig. 5, *P.*). is derived almost entirely from the superficial stratum of the obliquo-rectus of the abdomen, and is continuous with it. Where the fibres diverge from the trunk-muscle and take their independent course over the coracoid and to the humerus, they lose the tendinous inscriptions, *i.e.* in the last four inches of their course. A few fibres are derived from the sternum; and as the muscle passes over the hinder part of the coracoid it acquires some addition from muscular fibres which arise from the coracoid. It is inserted into the radial edge of the radial tubercle near the upper end of the humerus, none of the fibres extending beyond this tubercle. Its anterior edge is continuous with fascial tissue superficial to the precoracoid and extending over the neck[1].

The coracoid and precoracoid cartilages in this animal are very large and form a considerable part of the glenoid cup; and the muscles arising from them are numerous, almost surround the head of humerus, and are difficult of interpretation. They arise chiefly from the outer surface or the edge, and are as follows.

1. A broad thin muscle, arising from the outer surface of the sternal or epicoracoid edge of the coracoid superficial to the *biceps*. It crosses the muscular fibres of the *biceps* superficially and transversely and converges to be inserted into the summit of the upper part of the radial tubercle of the humerus, just above the pectoral. It may be called *epicoraco-humeral* (Fig. 17)[2]. Some of its superficial fibres are blended with those of the under surface of the pectoral, and it is not improbably the representative of the *pectoralis minor* of mammals.

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[1] This is the fascial investment already spoken of (p. 2) as covering the body. Schmidt, Goddard, and van der Hoeven, speak of the connection of the pectoral with the sternum and coracoid, but do not mention its relation to the external oblique, or to the fascial tissue.

[2] It corresponds, I think, with that described under this name in the Echidna, by Mivart. *Trans. Linn. Soc.* xxv. 388.

2. *Precoraco-brachial* (Fig. 17, *P. c. b.*), arises from the whole of the outer surface of the precoracoid cartilage, with the exception of the marginal part. It lies in the same plane with the *epicoraco-humeral*, indeed is almost continuous with it, and is inserted, in close connection with it and with the pectoral, into the radial side of the uppermost part of the radial tubercle of the humerus[1].

3. *Coraco-brachialis longus* (Figs. 17 and 18, *C. b. l.*) is the largest of the muscles arising from the coracoid. It arises from the hinder edge of the coracoid and divides into two portions. Of these, the larger and inner or lower division is inserted into the ulnar edge of the humerus for a quarter of an inch above the internal condyle: the other division, being nearly as large, is partly inserted into the side of the long tendon of the biceps, while a bundle of its fibres is continued on over the elbow, and is inserted into the ulna near the joint.

This last-described division must represent the short or coracoid origin of the biceps in Man. There is no trace of it in Menobranch Axolotl or Newt. The muscle in them though large is confined to the humerus in its insertion.

4. *Coraco-brachialis brevis* (Fig. 17, *C. b. br.*) arises from the coracoid close to the shoulder-joint, between the preceding muscle and the joint, and also from the external surface of the hinder part of the coracoid near the joint. It passes beneath the *biceps* to the ulnar side of the humerus near the shoulder-joint, and to the base of the ulnar side of the radial tubercle of the humerus beneath the *coraco-brachialis superficialis*. It corresponds with the ordinary mammalian coraco-brachial.

The median nerve passes between these last two; while the ulnar vessel, and in animals where it is present the ulnar nerve also, continues its course behind both.

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[1] This muscle is called *subclavius* by Mivart, in his description of Menopoma and Menobranch, *Proc. Zool. Soc.* 1869, pp. 265 and 460, though he regards it as the same as that named by him *epicoraco-humeral* in the Echidna. The relations of the muscle to the mammalian *subclavius* do not appear to be sufficiently clear to induce me to follow in the application of that name to it; and it arises from the precoracoid rather than from the epicoracoid part of the girdle. In Menobranch it is inserted into the summit of the radial tubercle, and its under surface is blended with the supra-scapular which makes its appearance in that animal though quite absent in Cryptobranch.

5. *Coraco-brachialis quartus* (*subscapularis*) arises from the margin of the coracoid and also of the scapula forming the inner edge of the glenoid cup, extending from the origin of the *coraco-brachialis brevis* to and over that of the triceps and also a very short distance upon the adjacent inner surface of the scapula. It separates the origin of the *coraco-olecranalis* from the capsule and from the origin of the *triceps*. The latter expands somewhat into the capsule, and so separates this muscle behind from the capsule. With that exception it is in immediate contact with the capsule which is thin under it. It is inserted into the upper part of the humerus behind the preceding, that is, just behind the ulnar edge between the *coraco-brachialis brevis* and the inner or third origin of the triceps. Indeed some of its fibres are continous with the former of those muscles in front, and with the latter behind.

This muscle spreading itself to a greater extent upon the internal surface of the scapula in some animals becomes the subscapular. It is called subscapular by Mivart in Menopoma and Menobranch. In the latter animal its extension upon the inner surface of the scapula is rather more decided than in Cryptobranch.

6. *Coraco-olecranalis* arises, by a tendinous band, from the edge of the coracoid, near the joint, internal to the middle of the preceding muscle, which separates it from the joint. It soon becomes muscular, descends the ulnar side of the arm dorsally, joins the triceps and is inserted with it into the inner side of the olecranon.

This coracoid accession to the *triceps* is common in Reptiles as well as in Urodelans. It results from the large relative size of the coracoid, and reminds us of the accession which the *quadriceps extensor cruris* in these animals receives in the form of what I have called *internal rectus* from the inner side of the front of the hip-joint. Only, in consequence of the difference in the rotation of the two limbs, the extensor of the forearm being directed backwards, gains its accession from the back of the shoulder-girdle, while the extensor of the leg being turned forwards gains its accession from the front of the pelvic girdle.

The *coraco-olecranalis* is also an example of the deviation of a member of the flexor series to an extensor function: just as the *biceps flexor cruris* is an instance of the deviation of a member of the extensor series to the flexor function, the office in each instance being determined by the position and attachment.

7. *Coraco-radialis*, or *biceps* (Fig. 17, *B.*), arises from the

external surface of the coracoid, between the epicoraco-brachial (*pect. minor*) and the short coraco-brachial, as a fan-shaped muscle, the fibres of which pass across the short coraco-brachial and soon converge into a long tendon, which runs down beneath the pectoral. Having passed the pectoral it receives the fibres of the long coraco-brachial, passes over the elbow-joint, and is inserted into the palmar surface of the upper end of the radius close to the joint. It is supplied by the nerve which perforates the scapula and which supplies also the superficial coraco-brachial.

I find the *biceps* corresponding with the above and distinct from the *brachialis anticus* in Menobranch, Newt, and Axolotl. In the Newt the long thin tendon is more closely related to the *brachialis anticus*, but does not seem to derive muscular fibres from it. As above mentioned, it does not in any of these animals derive fibres from the *coraco-brachialis longus*.

The *Brachialis anticus* arises from the radial side of the radial tubercle of the humerus, close, but on the opposite side of the tubercle, to the insertion of the pectoral, and beneath the insertion of the *dorsalis scapulæ*[1]. It passes along the shaft of the humerus, deriving no fibres from it, passes over the elbow superficial to the *biceps* tendon, and is inserted about equally into the radius and ulna. Its foremost fibres are inserted into the ulnar side of the radius at a short distance from the joint, nearly in the situation corresponding with the middle of the insertion of the supinator longus in ourselves. Its hinder half, passing between this radial insertion and the insertion of the *biceps*, is attached to the adjacent palmar surface of the ulna.

ON THE DORSAL ASPECT OF THE GIRDLE AND ARM.

The *trapezius* already described, (p. 30).

Latissimus dorsi arises from the fascial tissue over the dorsal muscle, extending, forwards, nearly to the head, overlying the hinder part of the trapezius and, backwards, half way to the pelvis. It is a thin muscle and its edge is not very defined in front or behind. The fibres converge and are blended with the upper part of the scapular origin of the *triceps*. Through the medium of it some are connected with the hinder margin of the scapula near the glenoid cavity; but it has no direct attachment to the scapula, and we cannot trace any of its fibres to the humerus.

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[1] I may observe that neither in this nor in the hind limb is the surface for attachment of muscles increased by intermuscular septa extending from the sides of the humerus and femur.

In these animals, in Reptiles and Birds, the *lat. d.* overlaps the *trapezius;* the reverse being the case in mammals.

Dorsalis scapulæ (Fig. 17, *D. s.*) arises from the outer expanded surface of the supra-scapula. It is a long trumpet-shaped muscle, and is inserted into the radial side of the radial tubercle of the humerus beneath the insertion of the *pre-coraco-brachial.*

This is in Cryptobranch the only muscle, with the exception of the few fibres of the *subscapularis* above mentioned, passing from the scapula to the humerus. In Menobranch there is in addition a muscle, blended with the deeper part of the precoraco-brachial, which represents the *supra-scapular*. The *dorsalis scapulæ* must represent, in the main, the *infra-spinatus*. Its superficial part, probably, becomes in other animals developed so as to contribute to the scapular part of the *deltoid*, and its hinder part is segmented as the *teres minor*. The *clavicular* part of the *deltoid* corresponds probably, to some extent, with the superficial fibres of the *precoraco-brachial*. Thus the clavicular and scapular parts of the deltoid come into relation with the *trapezius*, which is, in Urodelans, inserted into both precoracoid and scapula. They overlie the *supra-* and *infra-spinatus* and *teres minor* muscles, and have insertion corresponding with that of the *pre-coraco-brachial* and *dorsalis scapulæ*. The two parts are not uncommonly separate.

The few fibres of the *subscapularis* constitute the only appearance of muscle upon the whole of the large extent of the concave under surface of the coracoids and scapula, so that the surface is free to play upon the convex outer surface of the ventral muscle on which it lies.

Triceps arises by a tendon from the posterior edge of the scapula, immediately behind the joint and in close connection with the capsule, which indeed it strengthens by expanding upon it. It soon becomes muscular and is joined by the *latissimus dorsi.* A second head arises from the radial side of the humerus at the base of the tubercle, and a third from the hinder and ulnar aspect of the humerus. These all unite; and the muscle is inserted into the olecranon, being joined by the *coraco-olecranalis.*

PALMAR MUSCLES OF FOREARM AND HAND[1].

On the palmar aspect of the forearm the muscles form, as on the plantar aspect of the leg, a pronato-flexor mass, which is partially divided into two strata.

The SUPERFICIAL STRATUM (Fig. 18) is in three sectors. A radial sector representing the *Pronator teres* and the *Flexor carpi radialis*, large and thick, passes from the anterior or palmar part of the ulnar condyle, commencing close to the joint and extending a little way up the humerus above the condyle, crosses the forearm obliquely, and is inserted into an oblique line on the radius, which passes across its palmar surface from the ulnar to the radial edge, and into the radial edge as far as the wrist, also into the radial side of the two radial cartilages of the wrist. The upper edge of its insertion is immediately below that of the *brachialis anticus*. The deepest portion of the muscle, arising from the condyle close to the joint and passing to the ulnar edge of the radius, that is, to the upper part of the oblique line just mentioned, is in close contact with the *pronator quadratus* and at its insertion is blended with it, but is separated from it nearer the origin by the nerve (ulnar nerve) passing from the median nerve to the ulnar side of the forearm. This deepest portion of the muscle, which obviously corresponds with the ulnar origin of the *pronator teres* in man, is slightly separated from the rest by the branch of the median to the *flexor digitorum sublimis*[2] (see Fig. 18).

Flexor digitorum sublimis (Fig. 18, *Fl. d. s.*) forms the middle sector. It arises from the inner part of the ulnar condyle of the humerus, covering the preceding sector at this part. It soon lies on the same plane with it, occupies the middle of the forearm and receives an accession in the form of a portion arising by a flat tendon from the middle of the ulna (Fig. 19, *Fl. d. s.*) on the radial side of the *flexor carpi ulnaris*. The fibres of this portion join the under surface of the ulnar side of the general mass. It terminates over the carpus in a broad tendon, which is joined by a portion of the deep stratum, and divides into four tendons to the four[1] terminal phalanges. The disposition of the tendons corresponds almost precisely with that of its homologue in the hind limb (p. 26). Each subdivides into three, two lateral and a middle, the two lateral pass to the sides of the approximated ends of the metacarpal and the proximal phalanx, while the middle portion passes on to the second or terminal phalanx. In digit IV., which has three phalanges, the middle portion again subdivides into two, of which the deeper is attached to the base of the second phalanx, while the superficial runs on to the terminal phalanx.

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[1] I apply the term 'hand' to the distal segment of the fore limb simply for the convenience of distinguishing it from the distal segment of the hind limb.

[2] In the Scinc this portion, similarly related to the nerve and arising from the condyle beneath the rest of the muscle, is quite separate in its whole length, forming a *pronator intermedius*, and, serially, corresponding precisely with the *popliteus* in ourselves.

Flexor carpi ulnaris (Fig. 18, *Fl. c. u.*) arises from the inner condyle in conjunction with the *flexor digitorum*, and is inserted along the lower two-thirds of the ulna and into the proximal ulnar carpal bone; and some of its fibres are continued into the *abductor minimi digiti* which extends along the side of the metacarpus to the ulnar side of digit V.

The DEEP STRATUM arises from the plantar surface of the ulna commencing a little below the elbow-joint, also from the cartilages forming the middle or radial part of the carpus, but not those quite on the radial side. The fibres pass partly into the under surface of the radial part of the *flexor sublimis digitorum* and, partly, to the metacarpal and to the distal carpal bone on the radial side, also to the ulnar edge of the radius.

More accurately described the arrangement of the components of this stratum is as follows in three parts—*Pronator radii quadratus*, *Pronator manûs*, and *Flexor profundus digitorum*.

1. *Pronator radii quadratus* (Fig. 18, *Pr. q.*) arises from the upper part of the palmar surface of the ulna near the radial edge, and is inserted along the ulnar edge of the radius, its uppermost fibres blending at their insertion with the deepest fibres of the superficial layer (*pronator teres*). The upper fibres have some obliquity downwards from the ulna to the radius, the lower fibres are more transverse, and rather behind the upper.

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[1] Of the four digits in this limb digit IV. only has three phalanges, the remaing digits II. III. and V. having each but two phalanges.

The position of the muscle on the same level with the next portion of the deep layer indicates, as does the passage of the large branch of the median behind it, that it is a segment from the deep stratum rather than a third and hinder stratum which one might at first be disposed to regard it, and which view the position of its correspondent in the hind limb rather favours. By the connection of the muscle with the lower part of the *pronator teres* a continuity between the two muscles and between the two strata is established above. It is not so large, does not descend so low as its correspondent in the hind limb, and it is not placed behind the plane of the deep flexor stratum as the *pronator tibiæ* is in that limb. The difference in the last particular is caused by the greater size of the *pronator tibiæ* as well of the deep flexor stratum in the hind limb, so that the one comes to overlie the other.

2. The largest portion of the deep stratum, which I will call '*pronator manûs*' (Figs. 18 and 19, *Pr. m.*), arises from the radial side of the palmar surface of the ulna, beneath the preceding, and from the middle carpal cartilages. Its superficial fibres run into the radial part of the under surface of the *flexor sublimis*, just as the fibres from the ulnar origin of that muscle run into the ulnar part of its under surface. Its deeper fibres are inserted into the distal radial carpal bone and the base of the metacarpal of II. and III.

3. The *flexor profundus digitorum* (Figs. 18 and 19) is a flat band arising from the upper part of the palmar surface of the ulna between the *pronator quadratus* and the *flexor carpi ulnaris*. Like the corresponding band in the hind limb, it is completely segmented from the other muscles, and descends vertically. It passes deep, is connected with the distal carpal cartilage near the base of digit IV. detaching some fibres to the cartilage, and acquiring some from it; indeed the cartilage projects up through the muscle. The muscle now spreads out fan-like, and sends a division to each of the four digits. Each division is inserted chiefly into the base of the proximal phalanx, and a lateral detachment passes to one or both sides of the metacarpal. The division which passes to digit II. encounters another distal carpal cartilage, which also projects up through it, some of the muscular fibres passing to the cartilage and some passing from it. This trumpet-like muscle does not, as in the hinder limb to so great an extent, curl beneath the level of the pronator portion of the stratum (the *pronator manûs*),

because that portion is in the fore limb smaller, not arising from the ulnar part of the carpus; and the trumpet-like part of the *flexor profundus digitorum* is more on the same level with it, and lies on its ulnar and distal sides. Still the portion to digits II. and III. does, as in the hind limb, curl beneath the superficial fibres of the *pronator manûs* which pass into the under surface of the *flexor sublimis* going to those digits.

The short muscles resemble those in the hind limb (p. 28).

Carpo-metacarpales pass from the distal row of the carpals, each to the sides and middle part of its metacarpal. The middle are shorter than the lateral fibres, to give space for the

Metacarpo-phalangei which pass from the middle of the palmar surface of the metacarpals to the bases of the proximal phalanges.

Phalangeus is present only in digit IV. passing from the proximal to the second phalanx.

DORSAL MUSCLES OF FOREARM AND FOOT.

On the dorsal aspect of the forearm and hand the muscles form a 'supinato-extensor' mass, corresponding, serially, with the 'supinato-extensor' mass in the leg and foot, and, antagonistically, with the 'pronato-flexor' mass in the leg and foot, and in the forearm and hand. Like those, they are partially divisible into a superficial and a deep stratum.

The SUPERFICIAL STRATUM arising from the dorsal surface of the radial condyle and the adjacent part of the humerus, preponderates over the deep stratum more than is the case on the palmar aspect, It is in three sectors, a 'radial,' an 'ulnar,' and an 'intermediate.'

The radial sector representing the *supinator longus* and *brevis* and the *extensores carpi radiales* is the largest. It arises from nearly the whole of the part of the humerus mentioned, and is inserted into the whole of the dorsal surface of the radius. A portion of its fore part extends over the wrist-joint and carpus, and is inserted into the ulnar side of the base of met. II. representing the extensor *carpi radialis longior*[1] (Fig. 17, *Ext.*

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[1] In Menobranch it runs on to the radial carpal bone, but not to the metacarpus.

c. r.). The upper and deep part, which might be regarded as appertaining to the deep stratum, represents the *supinator brevis* and the part lying between these two, and inserted into the radius nearer the wrist, represents the *supinator radii longus* (Fig. 17).

The middle sector (*extensor digitorum sublimis*) arises from the humerus, superficially to the radial sector. Passing down the forearm and over the carpus, and receiving upon its under surface fibres from the *extensor digitorum brevis*, it divides to the four digits, passing to the terminal phalanges[1].

The ulnar sector (*extensor carpi ulnaris*) arises on the ulnar side of the other sectors, is inserted into nearly the whole of the shaft of the ulna, and a portion runs on to the ulnar side of the carpus.

The greater proportion of the fibres therefore pass from the humerus to the ulna instead of, as in most higher animals, from the ulna to the carpus. A similar deviation from the disposition in higher animals also is presented to a still greater extent by the corresponding stratum in the hind limb, the fibres of which pass largely from the femur to the tibia and fibula, instead of as in Man all passing from the leg to the foot.

The DEEP STRATUM is absent from the upper region of the forearm, except the part of it blended with and forming the deeper portion of the radial sector just described as representing the *supinator brevis*.

The uppermost part of the deep stratum, with that exception, arises from the dorsal surface of the lower end of the ulna, and crossing over the back of the radius and the carpus and the *extensor carpi radialis*, is inserted into the radial side of the base of met. II. It represents the *extensor poll. primus*. It may be best called '*Supinator manûs*' (Fig. 17, *Sup. m.*).

This is a better term than that of '*rotator carpi*' which I applied to the same muscle (*Journal of Anat.* IV. 48). It is one of the most constant muscles in the forearm, is the serial homologue of the muscle which I have called *supinator pedis* (p. 29), and, like it, is in the same plane with and in a higher level than the extensor brevis and often connected with it.

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[1] In Menobranch and in Saurians it stops, like its homologue in the hind limb of those animals and of AI, at the metacarpus, being inserted there in three portions; and small muscles arising from the metacarpus, close to its insertions, constitute the only extensors of the digits, and pass to the terminal phalanges.

The *extensor digitorum brevis* or *profundus* is a broad thin muscle arising from the proximal row of carpal bones, and joining the under surface of the *extensor digitorum sublimis* just above its division. It is connected with the preceding by a slip from the lower end of the ulna, which passes with it to the under surface of the ulnar part of the *extensor digitorum sublimis.*

Interossei are directed between the metacarpals descending rather lower on the ulnar than on the radial sides of the several bones.

The similarity in the disposition of the muscles in the middle and distal segments of the fore and hind limb is very closely in accordance with the similarity in the general structure and functions of the limbs. In each they constitute a 'pronato-flexor' mass upon the palmar or plantar aspect, and a 'supinato-extensor' mass upon the dorsal aspect; and the segmentation of these masses is much alike in each.

Especially in this so in the case of the SUPINATO-EXTENSOR mass, of which the division into two strata is equally distinct in each limb, and the *superficial stratum* arising from the condyle of the femur or humerus on the 'tibial' or 'radial' side, is in three parts, of which the middle passes to the digits, while the laterals are attached to the bones of the leg and forearm, and run on to the tarsus and carpus. The *deep stratum* in each limb is composed of a supinator of the foot or hand continuous with a short extensor of the digits.

In the PRONATO-FLEXOR MASS there is rather more difference in the two limbs, which is referable chiefly to the fact that segmentation is somewhat more advanced in the fore limb. In it the *superficial stratum* is more separate from the deep, though the two are still blended above and below; and the superficial stratum presents the three sectors—'radial,' 'ulnar' and 'intermediate'—which is not the case in the hind limb, where the muscular force is concentrated chiefly upon the flexion of the distal parts, and is less expended on the pronation of the tibia. This stratum moreover in the hind limb receives an accession from the tail and from the pelvis. With that exception the origin in the two limbs is alike—from the fibular condyle of the femur, and the fibula in the one, and from the ulnar condyle of the humerus, and the ulna in the other. The *deep strata* in the two correspond with an exactness which is scarcely modified by the difference in the number of the digits, each consisting, after the pattern of the dorsal antagonistic stratum, of a pronator of the foot or hand continuous with a deep flexor of the digits.

There is, however, this difference between the antagonistic deep strata, viz. that a distinct vertical band or strip is in both limbs segmented from the whole length of the pronator portion, and joined more or less completely to the short flexors constituting that which I have called the deep flexor of the digits; whereas, in the dorsal aspect, the short or deep extensor is connected only with the lower edge of the supinator.

MUSCLES OF THE HEAD. (Figs. 5 and 20.)

I have already (p. 30) described the *subcutaneus colli.* Beneath it is the *depressor mandibulæ,* presently to be noticed. Next lies the *constrictor faucium,* which arises from the fascial tissue between the *depressor mandibulæ* and the *trapezius.* Narrow at first, it radiates out beneath the neck and the hinder part of the broad interval between the mandibular rami and meets its fellow of the opposite side at the middle line.

The *Mylo-hyoid* arises from the hinder extremity of the cornu of the hyoid and the ligament[1] which connects the hyoid cornu with the suspensory apparatus of the jaw, as well as from the suspensory (glenoid) cartilage where it projects behind between the mastoid and the pterygoid bones, but not from the angle of the jaw itself, being separated from it by the insertion of the digastric. It passes forwards and radiates on the deeper surface of the subcutaneous muscle, and in connection with it is inserted into the inner part of the ramus of the lower jaw.

Genio-branchial, a long muscle, passes from the hinder part of the posterior branchial cartilage to the hinder surface of the lower jaw, at a little distance from the middle line.

Branchio-hyoid, a thick muscle, arises from the hinder part of the posterior branchial cartilage, its origin being by tendinous fibres from the deeper surface of the cartilage and by numerous muscular fibres which almost entirely enclose the cartilage; it arises also from the hinder part of the anterior branchial cartilage, and runs forwards to be inserted into the approximated parts of the basis and cornu of the hyoid.

Intermandibular consists of fibres passing transversely across the middle line from one side of the lower jaw to the other beneath it.

Temporal is a large muscle arising by a broad tendon from the frontal and parietal bones, near the middle line of the skull, and by a thick portion running backwards in the groove internal to the suspensory apparatus (the squamous bone and the ridge in the parietal upon which it abuts) to the dorsal spines of the three foremost vertebræ, from which it arises by means of a strong tendon. It forms a thick mass, bounding the orbit behind, and filling up the wide pterygoid fossa on the side of the skull, but not deriving many fibres from the bones there. The fibres converge to be inserted into the upper surface of the lower jaw, and particularly the inner or 'surangular' part of it, a little in front of the articulation with skull. Some of the fibres arising from the pterygoid probably represent the *external pterygoid* muscle.

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[1] In the back of that ligament there is a distinct though small piece of cartilage (stylo-hyal) between the extremity of the cornu (cerato-hyal) of the hyoid and the mastoid part of the suspensorial cartilage. Hyrtl found no cartilage in this ligament, though he mentions one as present in Menopoma.

Masseter, a thick muscle, arises tendinous from along the upper surface of the bone ('squamous,' as it appears to me), forming the upper part of the suspensorium, and descends to be inserted into the outer surface of the lower jaw, for an inch in front of the joint.—A considerable mass of muscle arises from the anterior surface of the suspensorium and is inserted into the upper surface of the jaw between the temporal and the mastoid. It is partly separated from the masseter by areolar tissue, in which branches of the third division of the fifth pass outwards to the side of the head and to the lower jaw. Its fibres are, however, blended to some extent with those of the masseter and of the temporal; and I cannot tell whether it should be regarded as appertaining more particularly to either, or to both, or as constituting a distinct pterygoid muscle.

Digastric, a strong muscle, arises from the retiring angle between the suspensorium and the back of the skull behind, near the auricular opening, and from the edges of the squamous, the mastoid, the parietal and exoccipital as well as the cartilage which they there surround. At its origin it is between the origin of the masseter from the squamous bone and the insertion of the dorsal muscle of the trunk into the exoccipital (Fig. 20). It lies on the groove of the mastoid along the back of the suspensorium, and is inserted into the hinder part of the angle of the lower jaw, just above the depressor maxillæ; but a distinct and strong bundle of its fibres passes on tendinous behind the jaw along the hinder surface of the suspensory ligament of the hyoid to the cornu of the hyoid. It is here overlapped by the mylo-hyoid, or those fibres rather of it which are attached to the suspensory ligament of the hyoid and the suspensory cartilage of the jaw.

The close connection of these parts—angle of jaw and its suspensorial cartilage—with the cornu of the hyoid and its suspensorial ligament, together with the insertion of the digastric into the angle of the jaw and the hyoid cornu, are interesting and important in relation to the remarkable course of the digastric to the hyoid and to the jaw, in ourselves.

Depressor Mandibulæ arises two inches behind the head from the fascial tissue, near the middle line, beneath the *subcutaneous colli*, between it and the *constrictor faucium*, forms a band about half an inch broad, the fibres of which converge to be inserted tendinous into the extremity of the jaw close to the preceding.

THE NERVES OF THE HEAD (Fig. 20).

The tough areolar tissue of the animal and the numerous accompanying veins rendered the dissection of the nerves difficult.

For an account of the nerves in the cranial cavity, I may refer to Figure 22 and the description of it.

THE OPTIC passes from the skull by a separate foramen, through the orbit, to the eye. Mr Anningson, in careful dissection of both orbits, could not discover the third, fourth, or sixth nerves in the orbit. The third and fourth were however found in the cranial cavity very small, and are represented in Fig. 22. Schmidt, Goddard, and van der Hoeven state that the sixth is a branch from the fifth in the orbit. This we did not find.

The three divisions of the FIFTH nerve are quite distinct.

The first, or OPHTHALMIC division, and the second, or SUPRA-MAXILLARY, escape from the skull by a common hole, though separated by a fibrous band.

The OPHTHALMIC is a large nerve, crosses above the optic, gives a *supra-orbital* branch, which passes to the integuments above the eye, and which, on its way, supplies nerves (*ciliary*) to the eye. Soon after entering the orbit, the ophthalmic detaches a large branch which runs beneath the eye, and at the margin of the orbit joins a long branch from the third division of the fifth. The resultant trunk passes through an infra-orbital hole, and is the *infra-orbital* nerve. Many small branches are given off by both nerves before they unite. The ophthalmic also, immediately after crossing the optic, gives a branch (*nasal*) to the nose.

The SUPRA-MAXILLARY, or second division of the fifth, runs along the floor of the orbit beneath the optic nerve and divides into branches, which pass inwards to the nose and forwards to the maxilla.

The INFRA-MAXILLARY, or third division of the fifth, emerges through a large hole at the front of the base of the suspensorial projection for the jaw, between the temporal and masseter muscles, and gives branches to both. Its *dentary* branch runs outwards beneath the masseter muscle, between it and the muscle arising from the front of the suspensorium which it supplies, then dips down to the lower jaw, and enters it by two branches through two foramina. A branch of the infra-maxillary runs forwards over the temporal muscle, on the outer side of the eye, gives off numerous branches upon the upper jaw, and joining a branch of the ophthalmic, as above described, forms the infra-orbital. A branch passes backwards beneath the masseter where it comes into contact with the seventh nerve, communicates with it, runs outwards with it, and turns forward along the outer side of the ramus of the lower jaw.

The SEVENTH nerve emerges from the skull in the retiring angle between the suspensorium and the occiput, and divides into two chief branches. One of these pierces the digastric muscle, supplies it, the depressor mandibulæ, the subcutaneus colli, and the constrictor faucium. The other chief branch passes beneath the digastric upon the suspensorium and along it, communicates with the branch of the fifth which has come beneath the masseter to this point, passes over the ramus of the lower jaw, and runs along beneath it supplying the mylo-hyoid and the subcutaneus colli, and reaching the intermandibular muscle. A branch also passes along the side of the lower jaw in company with the branch of the third division of the fifth.

The *Vagus* on its first appearance in the neck is large, and immediately gives off branches to the *branchio-hyoid* muscle and probably to the other branchial muscles (though these were not made out), small branches to the *digastric* and *depressor mandibulæ*, the *constrictor faucium*, and a large branch to the *trapezius*, also a long LATERAL nerve, which runs backwards along the lateral septum, in company with the lateral vessels, continuing its course to the tail without, apparently, giving off any branches. Having arrived at the tail, it gives off branches and communicates with the other nerves.

The branches above mentioned correspond with branches in ourselves from the 7th and 9th, and with the spinal accessory.

The office of the lateral nerve is probably to harmonize and produce simultaneous action of the several segments of the lateral muscle. It differs in the Cryptobranch from the same nerve in the Fish in that its distribution is limited to the lateral muscle of the tail, which indicates that the simultaneous powerful contraction of the parts of the lateral muscle in this animal are confined to or take place chiefly in the tail.

THE SPINAL NERVES.

The several spinal nerves, emerging through the neural foramina behind the transverse vertebral processes, cross above (dorsally, with regard to) the deep lateral vessels which traverse the holes in the roots of the transverse processes, and lie above the lateral septum. They supply the several segments of the trunk-muscles, taking their course behind the respective fibrous septa or inscriptions, and in addition send nerve-trunks to the limbs. Each nerve, immediately after its emergence from the vertebral foramen, above the lateral septum, divides into a POSTERIOR or DORSAL, and an ANTERIOR or VENTRAL SPINAL nerve (Fig. 21). The former divides into branches, which are directed upwards and outwards, in front and behind the articulating processes, to the dorsal muscles and the skin. The cutaneous branch (Fig. 21, *C.*) runs in front of the articulating processes outwards with a slight inclination upwards, behind the rib and the transverse septum passing dorsally from it, to the skin. The muscular branches radiate into the surrounding dorsal muscle. The ANTERIOR SPINAL or VENTRAL nerves (*v*) pass through the lateral septum so as to come into contact with the *subvertebral rectus* and its prolongations, and take their course behind the several ribs and the transverse intermuscular septa, and supply the ventral muscles, the skin and the limbs.

The first cervical nerve (SUBOCCIPITAL) passes through a foramen in the atlas direct to the foremost portion of the *subvertebral rectus* and the adjacent dorsal muscle. The second cervical nerve passes to the next portion of the *subvertebral rectus*, and a branch traversing that muscle reaches the 3rd nerve and so enters into the formation of the brachial plexus.

The BRACHIAL PLEXUS (Fig. 4) is formed by branches from the 3rd, 4th, 5th and 6th spinal nerves, with that just mentioned from the 2nd.

The third cervical nerve, joined by the branch from the second, divides into four. No. 1 joins the fourth spinal nerve. No. 2 passes in front of the precoracoid and is lost apparently in the areolar tissue and skin of that region. No. 3 traverses the coracoid hole and supplies the *coraco-brachialis superficialis*, the *biceps*, and perhaps the *coraco-brachialis brevis*. No. 4 supplies the *omo-hyoid*.

Its branches correspond with some of those which in man pass from the upper part of the cervical plexus, and form the EXTERNAL CUTANEOUS OR MUSCULO-CUTANEOUS mass; and they correspond serially with the OBTURATOR nerve in the hind limb. The branch to the omo-hyoid is to be associated with the absence of a hypoglossal nerve: at least we could not discover that nerve in the dissection of the neck or in the interior of the skull.

The fourth spinal nerve crosses behind the origin of the external oblique from the second rib, is connected with the third and fifth nerves by commissural trunks, and gives off scapular branches, which pass beneath the scapula (SUBSCAPULAR) also to the *latissimus dorsi*, *dorsalis scapulæ* and *precoraco-brachial* muscles, and a cutaneous branch (CIRCUMFLEX) to the outer side of the arm.

The nerves to the last two muscles might be designated SUPRA-SCAPULAR because they supply the muscles (*dorsalis scapulæ* and *precoraco-brachial*) which must, in part any rate, answer to the muscles (*infra- and supra-spinatus*), which are, in ourselves, supplied by the supra-scapular nerve. It is interesting to observe the nerves in this animal taking a course, behind the scapula to supply the muscles on the dorsum of the scapula, corresponding with the course, behind the ilium, which is usually taken by the GLUTEAL nerves in their passage to the muscles on the dorsum of the ilium.

The same nerve supplies the *triceps*, and perforating the long and the outer heads of that muscle descends, as the MUSCULO-SPIRAL or RADIAL, between them and the humerus, then between the triceps and the brachialis anticus, and then between the latter and the extensor muscles arising from the outer condyle. It supplies those muscles, and divides into two branches (Fig. 17), of which one perforates the extensor mass of muscles, becomes superficial, and runs along tho radial edge of the forearm and the radial side of digit II. (digit I. is missing): the other branch crosses deeply, between the extensor mass and the radius, to the back of the forearm, where it communicates with a posterior interosseous branch from the median and with the posterior ulnar branch of the median (the branch that is of the median which has descended through the triceps). It then descends the back of the forearm, under the extensor muscles, perforates the *supinator manûs*, and divides, supplying the apposed sides of digits II. and III., also the apposed sides of digits III. and IV. (Fig. 17).

The course and disposition of this nerve corresponds closely with those usually presented by the radial in higher animals, even to the share it takes in supplying the digits. It is derived from the middle of the brachial plexus in connection with the circumflex and subscapular, and is distributed exclusively to the muscles upon the dorsal aspect of the limb.

The fifth spinal nerve is connected by a commissural branch with the fourth, and receives the greater part of the sixth, that nerve merely sending off, besides, a cutaneous branch. It passes between the origins of the external oblique, from the 3rd and 4th ribs, and supplies branches to the *pectoralis* and *coraco-brachialis longus* and probably *brachialis anticus*, though the branch was not traced to that muscle. High in the arm it sends a long nerve (POSTERIOR ULNAR, or, better, INFERIOR MUSCULO-SPINAL) which, turning outwards to the back of the arm, perforates the short or ulnar origin of the *triceps* and descends through the triceps to the radial side of the olecranon. This nerve (Fig. 17) then pierces the *extensor carpi ulnaris*, and having reached its deeper surface and communicated with the radial and with the posterior interosseous from the median, runs along the dorsal surface of the ulna, then over the carpus, supplies the small muscles in that situation upon the carpus and metacarpus, and is distributed to the ulnar side of digit v. and the apposed sides of digits IV. and V.

The main trunk of the fifth spinal nerve continues its course as the MEDIAN on the inner side of the arm. It passes over the upper surface of the humeral portion of the *coraco-brachialis longus*, between it and the *coraco-brachialis brevis*, keeps beneath the bicipital portion of the former muscle, and passes over the elbow between the tendon of the biceps, which is inserted into the radius and the portion of the *coraco-brachialis longus* which is inserted into the ulna. At the elbow it divides into two trunks, an ANTERIOR ULNAR and a MEDIAN, both of which disappear beneath the mass of flexor muscles arising from the inner condyle.

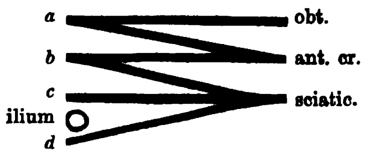
The ULNAR trunk (Figs. 18 and 19) takes its course through the flexor mass on the forearm, between the superficial stratum arising from the condyle and the ulna and the deeper stratum arising from the ulna and supplies both strata. One of its nerves passes to the *flexor dig. subl.* through the *pronator teres*, or proximal part of the condyloid stratum, just as the median in man passes between the condyloid and the ulnar origin of that muscle. Its terminal branch travels down between the *flexor subl. dig.* and the *flexor prof.* and, partly, also under cover of the *flexor carpi ulnaris*, supplying them in its course to the wrist. It runs over the carpus, supplies the ulnar side of dig. V., dips down between the muscles to dig. V. and, like the external plantar nerve in the hind limb, curls in beneath the *flexor profundus dig.*, and passes across towards the radial side of the limb, between that muscle and the *metacarpo-phalangei*, supplying the latter. At the interval, between digits V. and IV., it sends down a branch which supplies the apposed sides of those digits, and at the intervals between IV. and III. and between III. and II., it communicates with the branches of the median which are passing to supply the apposed sides of IV. and III. and III. and II.

The MEDIAN (Fig. 19) trunk takes a still deeper course beneath the *pronator quadratus*, supplying it, then over the front of the carpus beneath the *flexor profundus*, where it divides into three nerves, one supplying the muscles of the base of digit II. and perhaps passing on to the radial side of that digit; the second supplying the apposed side of digits II. and III., and the third supplying the apposed sides of digits III. and IV. The second and third nerves last mentioned each receives a twig from the terminal branch of the ulnar which runs across the metacarpal bones and muscles.

The ULNAR nerve always arises from the plexus in company with the MEDIAN, and not uncommonly forms one trunk with it, not separating from it till the forearm. In the Cryptobranch the dorsal or posterior part of it shows a tendency to associate itself in its course with the radial or dorsal nerve-trunk of the limb forming the inferior musculo-spiral, which corresponds in mammals to the posterior branch of the ulnar in the fore limb, and to the external saphenous in the hind limb. The palmar or anterior part of the ulnar carries with it the muscular branches usually given off directly from the MEDIAN; and the trunk of the MEDIAN is continued on in a deep plane as the ANTERIOR INTEROSSEOUS to the carpus and digits.

NERVES TO THE HIND LIMB.

The nerves to the hind limb are derived from four spinal nerves (*a*, *b*, *c*, *d*). Of these the foremost (*a*) sends a branch to



(*b*) and runs downwards as the OBTURATOR nerve, pierces the *pectineus* where it is taking origin from the interior of the pelvis, traverses the small obturatar hole in the pelvic shield, and supplies the adductor muscles arising from that shield. Whether it extends to the superficial stratum (*gracilis*, &c.) there situated, could not be ascertained with certainty. A branch from it however passes backwards to join the branch of the sciatic, which enters the hinder (*flexor cruris*) part of that stratum.

This connection with the sciatic is interesting in relation to the fact that the correspondent of the OBTURATOR nerve in the fore limb—the perforator of the coracoid or MUSCULO-CUTANEOUS—supplies in part or wholly the flexors of the forearm.

The second nerve (*b*) sends a branch to unite with the third and fourth (*c* and *d*) in forming the sciatic and then descends, over the brim of the pelvis upon the *iliacus* muscle, as the ANTERIOR CRURAL nerve. It supplies the *internal rectus*, the *iliacus* and the *pectineus*. A long branch from it (INTERNAL SAPHENOUS) takes a deep course between the *pectineus* and the femur to the tibial side of the limb, where it emerges between the *gracilis* and *internal rectus* and descends on the tibial side of the knee and leg.

The deeper course down the thigh than in ourselves of the SAPHENOUS nerve is consequent on the extension of the pectineus downwards nearly to the knee (p. 20), so that the nerve has to pass under it to reach its wonted place of emergence.

The third and fourth nerves (*c* and *d*) pass from the spinal column, the one in front and the other behind the level of the ilium, unite and are joined by a branch from the second nerve (*b*) to form the SCIATIC, which emerging between the *ischio-femoral* and the *gluteus* or *pyriformis*, gives off several branches to the surrounding muscles, dorsal and plantar—to the *pyriformis, glutei, gluteo-rectus* and *biceps*, to the *caudo-femoral, caudo-crural* and *caudo-pedal*, and to the hinder part of the *flexor cruris* (*semitendinosus* and *semimembranosus*).

It gives off also the MUSCULO-SPIRAL or PERONEAL nerve (Fig. 10), which descends in the thigh under cover of the *biceps*, supplying it and passing above or in front of it at the knee, then runs beneath the *peroneus*, between it and the fibula, to join a large branch from the ANTERIOR TIBIAL and supply the *peronei* and the *extensor digitorum longus*. It descends on the front of the leg beneath the *ext. digitorum* superficial to the *extensor hallucis* and on the fibular side of the *extensor brevis*, and sends nerves to the fibular side of digit V. to the apposed sides of digits IV. and V., and ends in a nerve which joins the branch of the anterior tibial in the interval between digits III. and IV.

The PERONEAL or MUSCULO-SPIRAL nerve answers to the RADIAL or MUSCULO-SPIRAL of the fore limb, and not at all to the ULNAR, though its name might seem to imply the contrary. The differences between the musculo-spirals in the two limbs, that is between the peroneal and the radial, are dependent chiefly or entirely upon the difference in the direction of the rotation in the two limbs causing a variation in the direction best adapted for the nerve-course. This is probably the reason that the PERONEAL does not traverse the whole thickness of the *quadriceps*, but only that part segmented from it which becomes the *biceps*. Indeed where the rotation of the limb is complete, as in Man, the nerve does not traverse even the *biceps*, as it does in these lower animals, but only gets under cover of it or keeps along its hinder edge. For the same reason the nerves to the *quadriceps* pass in front of the pelvis as ANTERIOR CRURAL, while those to the *triceps* pass behind the shoulder-girdle bound up in the RADIAL.

The SCIATIC nerve (Fig. 10) then divides into two, which in the left limb pass on the two sides of the *femoro-fibular*, and are joined by a connecting trunk beyond it, so as to encircle the muscle. (In the right thigh the sciatic trunk passes on the tibial side of the femoro-fibular and divides subsequently.) The outer division (EXTERNAL POPLITEAL) supplies the *femoro-fibular*, sends a (SURAL) branch to the stratum of the flexor mass arising from the fibular condyle, passes between the condyloid and fibular part of the superficial stratum, descends between the two strata along the fibular edge of the *flexor profundus digitorum* (Fig. 11) between it and the origin of the *flexor sublimis* from the fibula. It passes beneath the tarsus, curls over (deeper than) the *flexor profundus*, and then runs across the metatarsus as far as digit II. between the *flexor-profundus* and the *metatarso-phalangei*. In its course it supplies the fibular portion of the *flexor sublimis*, the whole of the deep flexor stratum (*tibialis posticus*, *flexor profundus*, *flexor-hallucis* and *accessorius*), the small muscles in the sole, the fibular side of digit V., the apposed sides of IV. and V. Between digits III. and IV. and between II. and III. it joins branches from the POSTERIOR TIBIAL, and the combined nerves supply the apposed surfaces of these digits.

The inner division (INTERNAL POPLITEAL, Fig. 10) in the left limb pierces the *caudo-femoral* close to its attachment to the femur (in the right limb it passes on the fibular side of this tendon going between it and the *femoro-fibular*). It gives off a long branch which descends, gives filaments to the lower part of the flexor cruris (*semitendinosus* and *semimembranosus*), perforates it, and runs down on the tibial side of the leg and foot, accompanying the internal saphenous towards, and probably upon, the tibial side of the hallux. The latter part of its course corresponds with that of the superficial branch of the radial nerve upon the radial edge of the forearm. The next branches from the internal popliteal, in conjunction with branches from the external popliteal, supply both strata of the flexor mass. The nerve (Figs. 10 and 11) passes deeply beneath (in front of) the flexor mass and the *pronator tibiæ* or *popliteus* which it supplies, gives off the ANTERIOR TIBIAL, descends as POSTERIOR TIBIAL behind the tarsus and metatarsus, and divides into two branches, which, joined by branches from the external popliteal, supply the intervals between digits I. and II. and II. and III.; also, probably, the deep muscles on the tibial side of the sole.

The ANTERIOR TIBIAL nerve supplies the *tibialis anticus*, descends over the ankle and tarsus, and divides into two nerves; one passes superficially to the *extensor hallucis* over the tarsus towards, and we believed to, the interval between and the apposed sides of digits I. and II.; the other passed beneath the *extensor hallucis*, supplying it, and divides into nerves to the apposed sides of digits II. and III. and of III. and IV., these nerves being joined by the terminal branches from the peroneal.

The similarity in the course and disposition of the EXTERNAL and INTERNAL POPLITEAL nerves and their plantar branches with the course and disposition of the ULNAR and MEDIAN nerve and their palmar branches is what might have been anticipated from the similarity of the muscles in the corresponding parts of the leg and forearm. Dorsally the supply of the tibial digits, wholly or partly, by the anterior tibial derivation from the POSTERIOR TIBIAL nerve in this and other animals, would scarcely have been expected from anything in the construction of the hind limb. The anterior tibial nerve is in the fore limb represented in Cryptobranch by the branch of the MEDIAN passing dorsally to join the radial and inferior musculo-spiral. The fibular digits are supplied by the MUSCULO-SPIRAL (peroneal) of the sciatic and the ulnar digits by the inferior MUSCULO-SPIRAL branch of the median: the only difference being that the nerves to the outer digits in the fore limb keep company with the main nerves of the limb (median or median and ulnar) longer than their correspondents in the hind limb keep company with the sciatic. Or, it might be said, the MUSCULO-SPIRAL in the hind limb detaching itself from the main trunks carries with it the dorsal nerves of the fibular digits. In ourselves the dorsal nerve of the ulnar digits—the 'INFERIOR MUSCULO-SPIRAL' as it may be called—keeps company with the ULNAR NERVE to the middle of the forearm, and the dorsal nerves of the fibular digits (the external saphenous) is derived partly from the MUSCULO-SPIRAL or PERONEAL, and partly from the POPLITEAL.

The chief differences from the corresponding nerves in Man, in addition to those just mentioned, are (1) the deeper position of the digital branches in the palm and sole beneath, instead of superficial to, the flexor tendons. In the fore limb the branches to the ulnar digits are derived from the deep palmar branch of the ULNAR instead of from a superficial branch; and those of the radial digits come from the INTEROSSEOUS which (in Cryptobranch) forms the main trunk of the MEDIAN, instead of coming off near the elbow by a branch which separates from the interosseous upon the FLEXOR PROFUNDUS, and the size of which causes it to be regarded as the main trunk. (2) In the hind limb the EXTERNAL POPLITEAL is, in Cryptobranch, like the ULNAR, continued to the digits; whereas in Man the course of the nerves to the fibular digits is not along the fibula, with the nerve which accompanies the peroneal artery, and which is the representative of the ULNAR nerve, but with the POSTERIOR TIBIAL, which is the representative of the MEDIAN, till they reach the foot, where they separate, and form the EXTERNAL PLANTAR nerve.

An interesting feature in the nerves of this animal and its allies as compared with those of higher animals is the simple structure of the BRACHIAL and CRURAL PLEXUSES, which may be associated with the imperfect segmentation and specialization of the action of the limb-muscles. The office of these plexuses, we may conclude, is to ensure that harmony and those nice balancing modifications in the degree of action of the muscles—the opponents as well the co-operatives—upon which the adjustment and proper direction of the movements of the limbs depend. This, it may be inferred, is effected by such an arrangement of bundles in the plexuses that a certain number of the filaments of any nerve presiding over one muscle, or set of muscles, are distributed among the nerves destined to each of the other muscles or sets of muscles; so that an impression transmitted to one muscle or set of muscles is in duly ordered degree communicated to each of the other muscles. Where, consequently, the muscles are numerous, the interchanging branches between the nerves requisite for this purpose will be numerous and form a complicated plexus; and where the muscles are few the plexus will be proportionately simple. The same object may be attained by intercommunicating filaments between the nerves in the distal parts of the limb, or by two or more passing to the same muscle. Thus the ninth and the cervical nerves intercommunicate before supplying the *omo-hyoid* in ourselves, while the *sterno-mastoid* and *trapezius* are each supplied by branches of the spinal accessory and of the cervical nerves passing separately into them; and the communicating branches above described between the obturator and sciatic, and between the median, radial, and posterior ulnar at the back of the forearm, indicate that the offices performed by the proximal plexuses in ourselves are, to a greater relative extent, performed by distal plexuses or communications in the Cryptobranch.

The course which the nerve-current follows, like that of the blood-current, is, in each case, probably regulated or greatly modified by convenience; and a nerve in its way to a particular muscle takes usually the most direct course, and may attach itself to one set of nerves or another, according as either lies more across its path. I have already alluded to the difference in rotation of the fore and hind limbs as a cause of difference of distribution of the nerves in the two. The rotation in each limb attains its maximum in ourselves, and causes the divergence of the nerves in the two limbs to be greater than in the Cryptobranch. For examples; the extensors of the leg and of the forearm are both in that animal chiefly supplied by nerves passing behind the respective girdles; in Man the nerves to the extensors of the forearm pass behind the scapula, whereas those to the extensors of the leg pass in front of the pelvis.—In Cryptobranch, the nerves to the muscles on the dorsum of the scapula and to the pectoral pass behind the shoulder, and those to the muscles on the dorsum to the ilium and to the gracilis pass behind the hip; in Man the scapula being thrown as well turned more backwards, the nerves (pectoral and suprascapular) to the corresponding muscles in the fore limb pass in front of the shoulder, while those in the hind limb (obturator and gluteal) pass behind the hip.—In Cryptobranch the nerves on the palmar and plantar aspects of the two limbs below the elbow and knee present scarcely any difference. In Man the nerves to all the digits of the hind limb proceed together in the posterior tibial nerve as far as the ankle; the companion of the peroneal artery, which is the representative of the ulnar nerve, is a mere muscular branch; whereas, in the fore limb, the nerves to the ulnar digits take their course down the forearm in the ulnar nerve quite separate from the nerves to the other digits, which are bound together in what we call the median nerve. These points indicate, as do the variations observed in this and other animals and in man, that nerve-course is somewhat too arbitrary or too much regulated by convenience in each instance for us to be able to rely upon the disposition of nerves as at all sure guides to the discernment, in difficult cases, of the homological relations of muscles and other structures.

DESCRIPTION OF FIGURES.

They are all representations of dissections of the Cryptobranch unless it is otherwise specified.

Fig. 1. Transverse section through tail. *F.*, fascial investment covering the part, ensheathing the ventral and dorsal lateral muscles and sending down laminæ to the vertebral processes. *D.f.*, dorsal fat-mass in triangular space between fascial laminæ on either side descending to dorsal spines and superficial lamina passing across. *V.f.*, and *L.f.*, ventral and lateral fat-masses similarly situated. *S. l.f.*, supra-lateral fat-mass with posterior spinal nerve curling from beneath it. The infra-lateral fat-mass is similarly situated.

Fig. 2. Muscles of the left side of the tail, hinder part of abdomen, and dorsal aspect of left thigh. *D.*, dorsal muscle of tail. *V.*, ventral muscle of tail. The lateral septum is seen between these two. *I. c.*, The iliac part of ventral muscle (Ilio-caudal) passing over the ilium (*I.*) and continued into the internal oblique (*I. O.*). *E. O.*, external oblique which has been partly divided and reflected upwards and downwards to expose the internal oblique and transversalis. *E. O'.*, the part of external oblique attached to the spine of the pubes and extending upon the hip between (*Gr.*) gracilis and (*Pect.*) pectineus. *Tr.*, transversalis exposed by reflection of external oblique and removal of part of internal oblique. *Py.*, pyramidalis. *Il.*, iliacus. *Gl. r.*, gluteo-rectus. *B.* biceps. *R. i.*, rectus internus. *T. a.*, tibialis anticus. *Ext. d.*, extensor digitorum. *P.*, peroneus.

Fig. 3. Right side of hinder part of abdomen, of tail and right hind limb shewing the caudal muscles and the extension of the external oblique into the fascial tissue on the dorsum of the thigh. *D.*, dorsal muscle of tail. *I. c.*, ilio-caudal. *C.f.*, caudo-femoral. *C. cr.*, caudo-crural. *Isch. c.*, ischio-caudal. *E. O.*, external oblique reflected from around the ilium to show its connection with the ilium (p. 13). *E. O^4.*, external oblique of the left side inserted into the edge and horn of the prepubic cartilage.

Fig. 4. Interior view of the muscles on the left side of the under surface of the back of the abdomen with the nerves of the brachial plexus. *V.*, *V.*, right sides of the bodies of the vertebræ uncovered. *I. v.* inter-vertebral substances. *S. v. R.*, sub-vertebral rectus. *D. C.*, depressores costarum. *Tr.*, transversalis. *I. O.*, internal oblique seen in shadow through the hole cut in the transversalis. *N.*, Nerve lying between transversalis and internal oblique. In the upper part of the drawing are two separate portions of the internal oblique which arise from the fourth and fifth ribs. *C.*, coracoid. *P. C.*, pre-coracoid. *S.*, serratus. *Tr.*, trapezius. *L. S.*, levator scapulæ. *C. f.*, constrictor faucium. *V.*, Vagus nerve.

O. h. N., omo-hyoid nerve coming from the third cervical nerve. 6, the sixth cervical nerve, the hindmost contributor to brachial plexus, indicated by a dotted line where it is covered by the transversalis. It is seen in front of the transversalis joining the fifth cervical nerve.

Fig. 5. Under surface of fore-part of trunk, neck and shoulders. *E. O.*, external oblique passing into (*P.*) pectoral. The right pectoral and external oblique have been reflected with the coracoids showing *I. O.*, internal oblique attached to upper plate of (*S.*) sternum (p. 15); the lower plate is exposed beneath it. *Sc.*, scapula. *C.*, coracoid, *P. c.*, pre-coracoid. *C. b. br.*, coraco-brachialis brevis. *C. o.*, coraco-olecranalis. *O. h.*, omo-hyoid. *P. c. b.*, precoraco-brachial. *Ep. c. b.*, epicoraco-brachial. *D. s.*, dorsalis scapulæ. *B. H.*, Basi-hyoid with cartilaginous nucleus, behind its middle, in the branchio-hyoid ligament. *C. H.*, cornua of the hyoid. *E. C.*, entoglossal cartilage. B^1, B^1, first branchial arches with the copula (*C.*) between them. B^2, second branchial arch. *S. c. C.*, subcutaneus colli divided and reflected to either side and seen passing under and attached to the ramus of the jaw. *M. H.*, the mylo-hyoid. *D. M.*, depressor mandibulæ. *D.* digastric. *S. H.*, foremost part of internal oblique or sterno-hyoid passing to (*C.*) copula and entoglossal cart. *G. b.*, genio-branchial. *B. H.*, branchio-hyoid. *I. M.* inter-mandibular.

Fig. 6. Deep view of under-surface of neck with right fore-limb. *S. v. R.*, subvertebral rectus passing to base of skull. *L. sc.*, levator scapulæ. *Tr.*, trapezius inserted between pre-coracoid and scapula. *D. sc.*, dorsalis scapulæ. *S. C.*, subcutaneus colli. *Cr. f.*, constrictor faucium. *D. M.*, depressor mandibulæ. *D.*, digastric. *C.*, coracoid. *P. C.*, pre-coracoid.

Fig. 7. Diagrammatic representation of abdominal muscles more particularly of the external (*E. O.*) and internal (*I. O.*) oblique and the rectus. *E. O. R.*, the external layer of rectus formed by the fibres of the external oblique. *I. O. R.*, the deeper layer of rectus formed by the fibres of the internal oblique. *Tr.*, transversalis.

Fig. 8. Muscles of tail and left hind-limb: the latter has been turned up so as to shew the plantar surface. *D.*, Dorsal, and *V.*, ventral muscles of tail separated by the lateral septum. *I. c.*, ilio-caudal. *Isch. c.*, Ischio-caudal. *C. f.*, caudo-femoral. *C. cr.*, caudo-crural. *C. p.*, caudo-pedal. *I. f.*, ilio-femoral, or biceps. *F. f.*, femoro-fibular, or short portion of biceps. *P.*, pubes. *Gr.*, gracilis. *St.*, semitendinosus. *T. a.*, tibialis anticus. *Fl. d. s.*, flexor digitorum sublimis.

Fig. 9. Plantar aspect of left hind leg and foot. *C. p.*, caudo-pedal. *Fl. t.*, flexor tibiæ (semitendinosus, &c.). *Fl. p.*, flexor mass of foot. *Fl. d. s.*, flexor digitorum sublimis divided and reflected upwards and downwards. *Pr. p.*, pronator pedis, or part of flexor mass inclined to tibial side of foot with its superficial fibres running into under-surface of flexor dig. subl. *Fl. d. p.*, flexor digitorum profundus. *N.*, nerve to sole lying on Fl. dig. *Abd.*, abductor minimi digiti.

Fig. 10. Muscles and nerves on plantar aspect of left hind limb. *I.*, internal surface of ilium with fibres of internal oblique passing to and from it. *C.f.*, caudo-femoral. *C. cr.*, caudo-crural. *C. p.*, caudo-pedal joined by portion from ischium. *Fl. c.*, flexor cruris. *Gl. r.*, gluteo-rectus. *B.* biceps. *F. f.*, femoro-fibular. *S.*, sciatic nerve passing beneath ilium and sending nerves to above muscles. *P.*, peroneal nerve. *E. P.*, external popliteal. *I. P.*, internal popliteal. *Pr. p.*, pronator pedis. *Fl. d. p.*, flexor digitorum profundus. *Fl. d. s.*, flexor digitorum sublimis, of which the lower part has been removed.

Fig. 11. Muscles and nerves on plantar aspect of leg and foot. *Fl. c.*, flexor cruris. *a. a. a.*, flexor sublimis, divided and reflected upwards and downwards (p. 26). *Fl. p.*, flexor profundus. *Pr. p.*, pronator pedis. *E. P. N.*, external popliteal nerve. *I. P. N.*, internal popliteal nerve.

Fig. 12. Deep muscles of sole. *Fl. d. s.*, flexor digitorum sublimis turned up, and the lower part removed, shewing the cut edge of fibres which passed into *Fl. d. s.* *Fl. d. p.*, flexor digitorum profundus divided, the lower part removed. *Pr. p.*, pronator pedis rising at the lower part to join *Fl. d. s.* *T. m.*, tarso-metatarsals. *M. p.*, metatarso-phalangei. *Ph.* phalangei. *I.*, interosseus. *Abd.*, abductor minimi digiti.

Fig. 13. Back of leg and sole of Menobranch dissected to shew the flexor digitorum profundus nearly divided in two, the tarsal cartilage intervening between its crural and its pedal parts. *Fl. d. s.*, flexor digitorum sublimis. *Pr. p.*, pronator pedis.

Fig. 14. Deep dissection of plantar aspect of right hind leg shewing *Pr. t.*, pronator tibiæ. *Fl. c.*, flexor cruris reflected. *C. p.*, caudo-pedal. *Fl. d. s.*, flexor sublimis reflected upwards. *Pr. p.*, pronator pedis reflected; below it is blended with flexor subl. *Fl. d. pr.*, flexor profundus. *T.*, lower end of tibia. The fibular and posterior tibial nerves are shewn, the latter passing in front of pronator tibiæ.

Fig. 15. Muscles on dorsal aspect of left leg and foot. *C.*, condyles of femur. *I. R.*, internal rectus. *T. a.*, tibialis anticus passing to tarsus; *T. a'.* tibialis anticus inserted into tibia. *Gl. r.*, tendon of gluteo-rectus passing to lower end of tibia between extensor digitorum and tibialis anticus; *E. d.*, upper part of extensor digitorum turned to one side. *E. d'.*, portion of extensor digitorum joining peroneus (*P.*) *E. d''.*, extensor digitorum reflected downwards. *S. p.*, supinator pedis. *E. d. br.*, extensor digitorum brevis. *E. d. br'.*, slip from extensor brevis to supinator pedis. *Abd.*, abductor minimi digiti.

Fig. 16. View and letters similar to preceding. *I.*, interossei.

Fig. 17. Muscles of left forelimb, with the radial and inferior musculo-spiral nerves seen in the back of the forearm. *C.*, coracoid. *P. C.*, pre-coracoid. *S.*, scapula. *E. p. c.*, epicoracoid muscle. *P. c. b.*,

pre-coraco-brachialis. *B.* biceps, detached from the scapula and turned back to shew (*C. b. br.*) the coraco-brachialis brevis. *C. b. l.*, coraco-brachialis longus. *Pect.*, pectoral. *Tr.*, trapezius. *L. s.*, levator scapulæ. *D. s.*, dorsalis scapulæ. *Br. a.*, brachialis anticus. *Ext. c. r.*, extensor carpi radialis. *Ext. d. s.*, upper and lower parts of Ext. d. sublimis, of which the greater portion has been removed. *Ext. c. u.*, extensor carpi ulnaris. *Sup. l.*, supinator longus. *Sup. br.*, supinator brevis. *Sup. m.*, supinator manûs. *Ext. d. br.*, extensor digitorum brevis.

Fig. 18. Muscles of right forelimb. *C.*, coracoid with (*Ep. c. b.*) epicoraco-brachialis. *B.*, biceps. *H.*, humerus. *C. b. l.*, coraco-brachialis longus, with divisions to biceps, to ulna, and to condyle of humerus. *Pect.*, pectoral divided and thrown outwards. *Br. a.*, brachialis anticus. *Fl. c. r.*, flexor carpi radialis. *Pr. t.*, pronator teres perforated by the nerve to (*Fl. d. s.*) flexor digitorum sublimis, which has been divided and reflected upwards and downwards. *Fl. c. u.*, flexor carpi ulnaris. *Fl. d. p.*, flexor digitorum profundus. *Pr. q.*, pronator quadratus. *Pr. m.*, pronator manûs. *R.* radius.

Fig. 19. Muscles and nerves on palmar aspect of right forearm and hand. *Fl. d. s.*, flexor sublimis digitorum divided and reflected upwards to the humerus and towards the ulna and downwards at its attachment to the digits. *Fl. d. p.*, flexor digitorum profundus radiating to the digits with the carpal cartilages appearing through it. *Pr. m.*, pronator manûs divided and reflected. *Pr. t.*, pronator teres. *Fl. c. r.*, flexor carpi radialis. *Pr. q.*, pronator quadratus. *P.* phalangeus. *U.*, ulnar nerve and branches. *M.*, median nerve.

Fig. 20. Muscles and nerves on the upper part of the head. *T.*, temporal muscle of right side; on the left side the upper part of the muscle has been removed leaving only the part near the insertion. *M.*, masseter. On the left side the upper part has been removed (exposing the suspensorium with the dentary nerve in front and the seventh nerve behind); and the lower part has been turned back to shew its insertion into the lower jaw and the dentary nerves passing into the jaw. On the right side a branch of the third division of the fifth is seen emerging from beneath the masseter and joining the seventh. 7*a.* Conjoined branch of 7th and 5th—the submental nerve. In the left orbit are seen the ophthalmic nerve near the inner part of the orbit giving off the ciliary nerve and the supramaxillary, with the optic crossing from the inner side of the orbit over the latter. *H.*, hinder end of the hyoid cornu with (*St.*) styloid cartilage between it and the jaw. *D.*, dorsal muscle extending to head.

Fig. 21 represents a piece of the side from which the lateral muscle (*L.*) has been partly removed to shew one of the spinal nerves emerging from the vertebral foramen just behind the rib (*R.*) and dividing into anterior or intercostal or ventral (*V.*) and posterior branches. *C.* cutaneous nerve from the latter. The posterior branches pass in front and behind the articulating processes to the dorsal part of the lateral muscle. The anterior branch runs along the hinder border of the rib. *I.*, inscription in the dorsal muscle.

Fig. 22. View of the brain and cerebral nerves in situ, the upper part of the skull and the meninges with the fine areolar tissue which occupied the large interval between the dura mater and the skull having been removed. 1. The olfactory nerve expanding into the cerebral hemisphere (Schmidt, G. and V. der H. judged that there was a cavity in the hemisphere. In my specimen the part was too soft for this to be decided). The hypophysis was very large and occupied a distinct digital fossa on the upper surface of the basis cranii. There was also a Pineal Gland but much smaller. 2. The optic nerve passing from beneath the hemisphere. The two optic nerves are quite separate from one another, and do not cross, each running direct from the hemisphere to the orbit of the same side. 3. The third nerve (*motor oculi*) passing from beneath the hemisphere. 4. The fourth nerve passing from the strand at the side of the third ventricle. The third and fourth nerves escape through small foramina in the dura mater and apparently accompany the ophthalmic part of the fifth. 5. The fifth nerve passing from the side of the forepart of the brain bounding the fourth ventricle: it expands into the Gasserian ganglion as it enters the dura mater. 7. The seventh nerve passes from the side of the back of the brain bounding the fourth ventricle and divides into the portio dura and the auditory part. 8. Two nerves passing from the medulla oblongata, meeting as they enter a common hole in the dura mater and skull, and forming the eighth nerve. The anterior of the two is probably the glosso-pharyngeal, and the small nerve seen joining the vagus from behind is probably the representative of the spinal-accessory. They are so regarded by Schmidt, G. and V. d. H., who also describe a nerve which they traced through an anterior condyloid foramen as the 9th or hypoglossal nerve. We could not discover any representative of the 9th nerve in the cranial cavity.

ON THE COMPOSITION OF THE CARPUS OF THE DOG. By *Professor* W. H. FLOWER, F.R.S. (Read at the Meeting of the British Association, at Edinburgh, Aug. 7, 1871.)

THE number of the elements forming any part of the skeleton in the larger number of animals and therefore regarded as normal or 'typical', may be exceptionally reduced in certain species, either by absolute suppression or by the union of two or more elements.

This union may be brought about either by (1) *coalescence*, where a single part is formed by the fusion of two or more elements developed separately in the embryo; or (2) *connascence*, where a part which (as far as can be traced) has been single from the first, in one individual, represents by its form, situation and connection with surrounding parts, two or more distinct elements in another individual.

An example of coalescence in the carpus, is seen in the genus Salamandra, in which, according to Gegenbaur's observations[1], the *intermedium* and *ulnare* are distinct in the new-born, but united in the adult animal.

On the other hand, the *unciforme* of the mammal's carpus which represents the two carpal bones of the ulnar side of the distal row of reptiles, is, as far as is at present known, an example of connascence; for in no mammal has this bone been found to have origin in two distinct centres of ossification, or in separate cartilages.

This distinction is important, although it is obvious that it can only be employed in cases in which our knowledge of the development of the part is complete, and a gradual conversion of the less into the more perfect condition of union in successive generations and by various intermediate or transitional conditions is perfectly conceivable.

In the dog and other animals of the order Carnivora, as is well known, a single bone represents, by its position and relation to surrounding structures, the *radiale* and *intermedium* of the typical carpus, more commonly called in England the scaphoid and the lunar. In this, as in other similar cases among the Rodentia, Insectivora, &c. researches in the embryonic condition have not hitherto, according to Gegenbaur[1], shown any true coalescence of distinct elements.

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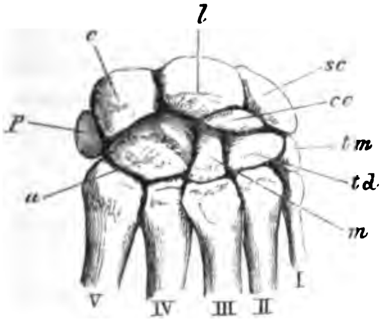
[1] *Untersuchungen zur vergleichenden Anatomie der Wirbelthiere*, 1tes Heft. *Carpus und Tarsus*, 1864, p. 5, and Pl. I. figs. 1 and 2.

The Carnivora, moreover, have always been included among the orders in which the *os centrale* (a bone found in monkeys, many Rodents, Insectivores, &c.) is wanting as a distinct element[2]. This bone, previously described as a dismemberment of one of the more constant bones of the carpus, is considered by Gegenbaur as a true primitive element of that region. He adds: "But what takes place in those cases in which it is wanting, has not yet been discovered. My endeavours in the examination of embryos, both of man and of many mammals, to obtain any indication have all been in vain, and I can only say that there are no grounds for the acceptance of its connection either with the *magnum* (Cuvier) or with the *scaphoid* (Owen)[3]."

A recent examination of the natural skeleton of a dog, about six weeks old, which I had prepared for the museum of the College of Surgeons of England, has fortunately thrown light upon both these questions; for I find that at this age, the



Dorsal surface of right carpus of young Dog, No. 4419 D Osteol. Series, Mus. Roy. Coll. Surg. London x. 2. *c* cuneiform or *ulnare*, *l* lunar or *intermedium*, *sc* scaphoid or *radiale*, *ce* central, *tm* trapezium, *td* trapezoid, *m* magnum, *u* unciform, *p* pisiform, I—V metacarpals.

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[1] *Op. cit.* p. 44.

[2] Gegenbaur, *op. cit.* p. 50. W. H. Flower, *Introduction to the Osteology of the Mammalia*, p. 258.

[3] *Op. cit.* p. 50.

so-called *scapho-lunar* bone, though well ossified, consists not only of a perfectly distinct *scaphoid* and *lunar*, but also of a third piece evidently corresponding to the *os centrale* of the typical carpus.

The two former are divided by a vertical suture in the usual situation, the *scaphoid* being rather the larger of the two. The *centrale* is a small wedge-shaped bone, with its broad end towards the dorsal surface of the carpus, where it appears in the form of a transversely elongated lozenge, articulating above (or proximally) with both *scaphoid* and *lunar*, and below (or distally) with the *trapezoid* and *magnum*, fitting into the groove between the two. It thus lies altogether between the first and second row of carpal bones. As it recedes from the dorsal surface it narrows to a point which does not extend so far as to appear on the palmar aspect of the carpus. It is rather smaller and more flattened than the corresponding bone (which remains permanently distinct) in a monkey, but has precisely similar connections. The disposition of these structures is exactly the same on both sides of the body.

Although it is desirable that this observation should be repeated in other Carnivora, it appears to me important as proving that in the dog at least, neither the *radiale* (scaphoid), *intermedium* (lunar), nor the *centrale* are suppressed, neither are they connate, but they are all developed independently and afterwards coalesce to form the so-called 'scapho-lunar' bone, and further, because it lends additional weight to the view of the nature of the *os centrale* advocated by the distinguished anatomist of Jena.

DESCRIPTION OF THE BRAIN OF AN IDIOT. By S. MESSENGER BRADLEY, F.R.C.S., *Lecturer on Human and Comparative Anatomy, Royal School of Medicine and Surgery, Manchester.* Plate V.

General History. THE idiot from whom the brain was taken which is here described, died from bronchitis in the Withington Workhouse, Manchester, of which he had been an inmate for fifteen years, at the age of 35. His parents, who are people of average intelligence, on being interrogated, stated that there was no other instance of idiocy, or yet of epilepsy or insanity in the family. It was difficult to correctly ascertain what height he was, as he always lay, or sat, coiled up into a ball, with his arms and legs acutely flexed upon themselves; he certainly would not have exceeded four feet, however, if it were possible to have stretched him out.

At death he weighed only 60 pounds; he was always extremely feeble, being indeed little more than skin and bone. His attitude in life was remarkable; he sat throughout the day huddled together like a tailor, upon a little bench, continually swaying to and fro, and constantly uttering a low moaning kind of note.

Senses and Intelligence. Both taste and hearing were properly developed, but he was blind from his birth. For some years preceding death there was opacity of both corneæ, with atrophy of the eyeballs. Up to the age of nineteen he never spoke, but he subsequently learnt to say a few words, which he would repeat parrot-like, when the cue was given him. They consisted in the repetition of much such a formula as the following: "Jaunty (his name was Jonathan Gorman, but he was always called Jaunty), good boy, Christians awake, happy morn, four and twenty blackbirds baked in a pie, Mother" (pronounced Mudd-der). This with the addition of some profane expressions completed his stock of learning. He scarcely ever varied his formula, although occasionally, like "Grip," he lost his way and mixed up his oaths and nursery rhymes in singular confusion.

His habits were filthy, and his passions violent: he never recognized any one, and always bit and tore at the man who daily carried him from his seat on the form, or chair, to the watercloset, where he made it his invariable rule to eat his meals: this strange custom he persisted in for many years before his death. He was not paralysed, but was quite incapable of any attempt at locomotion. He was equally unable to dress himself, or indeed to perform any of the functions of life unaided, beyond carrying his food from his plate to his mouth with his fingers.

He was very restless when lying down, and in tossing about from side to side he sometimes jerked his arms or legs against the edge of the bed, and when he did so, he invariably fractured a bone. These fractures always united, but owing to his extreme restlessness, it was found impossible to keep the fragments in apposition by any arrangement of splints or bandages, and in consequence of this almost incessant movement, the bones united at the most extraordinary angles; *e.g.* the femora and humeri, which were all fractured at one time or another, were so acutely bent upon themselves during the process of union, that the upper and lower fragments assumed an almost parallel position to each other. After death nine important fractures were counted, and several of less moment. In addition to these it was found that seven of the ribs had been broken at periods more or less remote.

Neither the expression of the face, when asleep, nor the external shape of the head, conveyed the notion that the man was idiotic. The face, which was quite the best part of him, was rather intelligent-looking than otherwise[1].

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[1] The skull was brachycephalic, measuring 6·5 across the vertex from side, and 6 inches from before backwards. I do not however think that this fact of brachycephalism is in itself of much value, or that the classification which Retzius founded upon the relative length and breadth of skulls is a good one. I am at present engaged with Dr Lyson in investigating the varieties of English Crania, and, without anticipating the paper we hope to publish on this subject, I may here state that we meet with extreme cases of dolicocephalism and brachycephalism amongst the English residents of our own town. Huxley in his remarks upon the 'Neanderthal' skull comes to much the same conclusion which we have arrived at, when he affirms that "cranial measurements alone afford no safe indication of race".

Weight and general appearance of the brain, and of its component parts. After removal of the membranes the brain weighed 28 ounces, which was made up in the following manner[1]:

The cerebrum		22·8 oz.
The cerebellum	Right hemisphere	2·5 ...
	Left hemisphere	2·0 ...
The pons and medulla		·7 ...
		28·0 oz.

The most striking peculiarity here is the disproportion in weight between the two cerebellar hemispheres, but in spite of the deficiency in the left half, it is noteworthy that the proportion to the cerebrum of the entire cerebellum, 1 to 5·5, is, as is usual in the brains of idiots, considerably higher than it is in healthy brains, where it is 1 to 7. When first removed from the calvarium the cerebellum was entirely concealed by the cerebrum, and at first sight the general appearance of the encephalon conveyed the idea of a small but normally developed brain.

On section the grey matter was found to average ·14 inch in thickness, and appeared paler than usual, but microscopically the cells presented a normal appearance. The sulci averaged half an inch in depth, but were deeper at the front than at the back of the brain, being ·6 inch in the frontal, and only ·4 inch in the occipital lobes. The pons varolii measured ·8 inch in thickness.

The cerebellum afforded the following measurements:—

Left hemisphere of cerebellum:

From before backwards	2·25 inches.
From side to side	·9 ...
From above downwards	1·5 ...

Right hemisphere of cerebellum:

From before backwards	2·5 ...
From side to side	1·2 ...
From above downwards	1·5 ...

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[1] This is not at all an extremely light brain for an idiot, and scarcely brings it into the category of micro-cephalic brains; instances being recorded of brains weighing respectively 16·6 oz. (Wagner's *Vorstudien*), 13·125 oz. (*Trans. Zool. Soc.* I. 343), 10 oz., and 5·10 oz. (*Trans. Phil. Soc.* 1864, Part III. p. 527).

Fissures, Lobes and Convolutions seen on the superior and outer aspect of the brain.

Fissure of Sylvius (*S*)—*Right side.* The horizontal limb was observed to extend within a very short distance of the intra-parietal sulcus (*IP*). The ascending limb (*S'*) ran into the second frontal convolution (2—2). *Left-side.* The horizontal limb did not run so far on this side as on the other by an inch.

Fissure of Rolando (*R*). This fissure was situated almost midway between the frontal and the occipital lobes, and consequently decidedly more anteriorly than is the case in well-developed brains. This is explained by the imperfect, post-natal, development of the frontal lobes. *Right-side.* Did not quite reach the horizontal limb of the fissure of Sylvius (*S*), so that the ascending frontal (4—4) and parietal (5—5) convolutions were continuous. *Left-side.* A similar disposition was met with on this side, but it extended quite into the longitudinal fissure.

External Parieto-occipital Fissure (*PO*). *Right.* Swept abruptly backwards, and then ran forwards and outwards for three inches towards the Parallel Sulcus (*P*) into which it merged. In consequence of this arrangement the first annectent convolution (*a*—*a*) was *apparently* not present, and the second (*β*—*β*) was removed to a greater distance than usual from the longitudinal fissure. *Left.* Of the usual extent, it cut the upper surface of the brain for the space of about half an inch.

Intra Parietal Fissure (*IP*). *Right.* The ascending limb ran parallel to the fissure of Rolando (*R*) as far as the longitudinal fissure: the horizontal limb (on the contrary) was extremely short. The ascending limb was separated from the fissure of Sylvius by the supra-marginal lobule (*A*). *Left.* Ascending limb not so extensive as on the right side, but horizontal limb somewhat longer.

Parallel Fissure (*P*). *Right.* Ran backwards into the external parieto-occipital fissure (*PO*) as before mentioned. The parallel fissure and the fissure of Sylvius were, however, not joined. *Left.* Parallel fissure separated from external parieto-occipital fissure by a distance of 1·5 inches.

The Lobes and Convolutions. The frontal convolutions of both hemispheres were non-symmetrical and fairly developed, though *relatively* small; they all sprang from the ascending frontal convolutions. Supero Frontal (*SF*) and Infero Frontal (*IF*) sulci on both sides interrupted by secondary convolutions. The third left frontal convolution was very well developed. Orbital convolutions presented nothing remarkable. The ascending Frontal (4—4) and ascending Parietal (5—5) convolutions were large and *partially* cut by secondary sulci. On the *right side* the lobule of the ascending parietal convolution (5′—5′) was connected with the angular gyrus (6—6), and ran back to the external parieto-occipital fissure (*PO*), which it crossed by a small bridge of white matter (the position of which is indicated by the mark *) lying ·2 inch below the surface, and hence concealed from sight until the sulcus was stretched apart. In this manner the parietal and occipital lobes were united by a first annectent convolution (*a—a*) which was hidden from superficial observation. On the *left* side the lobule of the ascending parietal convolution (5′—5′) was separated from the angular gyrus (6—6) by a shallow sulcus, but was connected in the ordinary manner with the occipital lobe by a superficial annectent convolution (*a—a*).

Annectent Convolutions (*a—a*), (*β—β*), (*γ—γ*), (*δ—δ*). *Right-side.* The first was deeply placed, as before stated, and was small. The second and third were also small, and almost separated from the parietal lobe by the near junction of a deep transverse fissure with the parallel fissure (*P*). Though small, they were present however. *Left-side.* Well and normally formed.

Lobule of the Supra-Marginal Convolution (A). *Right side.* Small, joined angular (6—6) and ascending parietal convolution (5—5). *Left side.* Rather large and more quadrilateral: united the same convolutions on this side as on the other. It is important to note the presence of this convolution in both hemispheres. In Professor Marshall's cases of the micro-cephalic brains of two idiots (reported in *Phil. Trans.* for 1864, Part III.) it was nowhere present. Both by him and by Gratiolet it is regarded as, perhaps, the most characteristically human of all the convolutions.

Angular or Bent Convolution (6—6). *Right.* Complex, divided into numerous secondary convolutions, and continuous with the second annectent convolution (β—β). *Left.* Markedly simpler, but also continuous with second annectent convolution (β—β).

Fissures, Lobes, and Convolutions of Internal and Inferior Surfaces of Cerebrum.

The *Calloso-marginal*, the *Calcarine*, and the *Dentate* fissures presented no peculiarity worthy of note.

Collateral Fissure. Right. This important fissure could not be said to exist at all on this side; but instead of this it was found that a branch of the parieto-occipital fissure joined a deep sulcus, one inch in depth, which ran at right angles to it, transversely across the brain, apparently cutting off the parietal from the occipital lobes. This transverse fissure (which was notably the deepest fissure in the entire brain) ran within ·2 inch of the parallel sulcus (*P*); if this junction had actually taken place, the parietal and occipital lobes would have been completely disjoined; but, as has been described, the annectent convolutions though small were present, and crept into the narrow space between the two sulci[1].

The *Callosal* and *marginal* convolutions were well developed: the *occipital lobule* was smaller than usual on both sides, but not otherwise remarkable.

Island of Reil. Quite concealed on both sides. Symmetrical in the two hemispheres, and consisted of three perfectly smooth, small, radiating convolutions.

The *Temporo-sphenoidal Lobe* was well developed, and nearly symmetrical on the two sides. On the *right side* the *external temporal* convolution was very unusually thin.

The *Corpora Striata* were rather smaller than the *Optic Thalami*. The ventricles measured 1·25 inches from side to side.

The *Corpora Quadrigemina*, although composed of their usual elements, were extremely small, being not more than half the usual size.

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[1] Gratiolet has figured a somewhat similar sulcus as existing in the brain of a porpoise (Leuret et Gratiolet, *Atlas de l'anat. comp.* 1857. Plate XI.), and in the brain of a six months' fœtus (*loc. cit.* Plate XXX. Fig. 1.).

Cerebellum. The vermiform process was imperfect: the *nodule* and *uvula* were present, but small; the *pyramid* and *commissura brevis* were entirely undeveloped. The weight and measurements of the cerebellar hemispheres have been given already; the deficient weight of the left hemisphere was due to a general imperfection in its development, and to the presence of a small Flocculus: on the right side the Flocculus was of average size.

The *Corpus Dentatum* was oblong, and measured ·25 inch in its longest diameter, which was from before backwards.

The laminæ were not so numerous as usual, and were unequal in number on the the two sides.

Superficial laminæ: Right side numbered 72. Left side numbered 62.

Specific gravity. The sp. gr. of the entire encephalon was found to be 1038, thus differing very little from the sp. gr. of healthy brains. The sp. gr. of separate parts was not taken.

Chemical Analysis. Professor Roscoe very kindly undertook the analysis of the brain for the purpose of ascertaining whether or not it was deficient in phosphorus. I extract from his report the following statements.

For this examination 36·34 grammes of solid brain, plus 27·20 cubic centimetres of the alcohol in which it was preserved, were taken, this being equal to 4·61% of the total brain, which, as delivered to him, weighed 790 grammes: the analysis of these combined materials yielded a percentage of phosphorus of ·370.

The fresh brain, however, weighed 28 ounces, which is equal to 871 grammes, and thus 100 parts of the dry brain were equal to 110·2 of fresh brain; so, to obtain a correct result we must state it in this form, $\frac{\cdot 37 \times 100}{110 \cdot 2}$, which gives a percentage of ·336 to the fresh brain. At the time of making this analysis, Professor Roscoe also ascertained the percentage of phosphorus in a perfectly fresh healthy brain, and found it gave ·310% of phosphorus; so that, though the entire quantity of phosphorus was less in the brain of the idiot than in the brain of the healthy man, the percentage was actually higher in the former than in the latter[1].

Condition of the bones. The state of the bones was so remarkable, that a month after death a rib, unbroken, which had been kept in maceration for some time, was removed for examination. It was dark in colour, offensive in odour, and greasy to the touch. Pressure caused the exudation of a thin fœtid fluid from the ends. The bone could be snapped with very slight force. A *scraping* placed beneath the microscope revealed the presence of vast numbers of oil globules, and granules. A *thin section* at first showed little else; but after the oil globules were removed, a process involving much time and trouble, the bone-structure itself came into view. The most noteworthy peculiarity appeared to be the large size of the Haversian canals and interspaces, all of which were filled with amorphous granular matter. Interstitial absorption had evidently been going on in the bones, loosening their component parts, and producing the singular softness of structure which characterised the bones during life. These changes were probably identical with those described by Dr E. Ormerod, as found by him in the bones of lunatics[2].

Remarks. This case presents some points of resemblance and some of contrast to the case of a deaf mute, described by Dr Broadbent in the November number of the *Journal of Anatomy and Physiology* for 1870, the chief of which appear to be the following.

In Dr Broadbent's case the third left frontal convolution was small; in my case it was well developed. In reference to this point it should be remembered that Dr Broadbent's patient was dumb during life, whereas the idiot, whose brain I have described, could articulate several words, but seemed to fail to grasp their meaning. In Dr Broadbent's case the annectent convolutions were deficient on both sides, so that the parietal lobes were almost completely separated from the occipital lobes.

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[1] I am indebted not only to Professor Roscoe, but also to his laboratory assistant Mr Rocholl, for the time and trouble expended in this analysis.

[2] Observations on a peculiar condition of the bones of two insane patients who had fractured ribs. By Edward Latham Ormerod, M.D. *Barthol. Hospital Reports*, 1870, page 65.

In my case this condition existed on one side only, the right, where indeed the separation was almost absolute. On the left side, on the contrary, the annectent convolutions were well developed. Dr Broadbent also noted that the angular gyrus was very small, which was not so in my case. In both cases it is interesting to observe that the lobule of the supra-marginal convolution was present on both sides.

In addition to these points there remain to be noted in my case, the existence of a very small and simple Island of Reil, extremely ill-developed Corpora Quadrigemina, an almost rudimentary condition of the vermiform process of the cerebellum, and a striking disproportion between the two cerebellar hemispheres.

What weight ought to be attached to the condition of the central lobe we probably have not yet the power to decide. The small size of the Corpora Quadrigemina is interesting when considered in connection with the state of congenital blindness which existed. The cerebellar peculiarities were very striking, but where the whole psychical and physical states were so much jangled and out of tune, it becomes difficult to determine to what extent the cerebellum operated as a separate pathological factor in the case, whether we regard the ideo-motor or excito-motor actions of the brain.

In considering such cases as these the causes of idiocy may be conveniently ranged under three heads: 1st, those dependent upon smallness of the brain itself, which would include not only micro-cephalic brains, but all encephala where any single part is ill-developed, or rudimentary; 2nd, those caused by imperfect anatomical *connection* of parts; and 3rd, those which are the result of imperfection in the cerebral structure itself, which would include all those cases where the microscope reveals imperfect histological development either in the cell or fibre elements; and also those cases where, though the histological structure appear normal, the chemist discovers noteable deficiencies in important cerebral constituents. In the case under consideration more than one of these causes seems to have been in operation; indeed it is probable that all three causes were at work to a certain degree. Let us briefly review some of the chief points of interest in this case.

The first to notice is the absence of any traceable predisposing or exciting cause; the parents were intelligent, they were not related, they could give no history of any case of mental aberration, or nervous affection in any shape as existing in the family.

The bodily condition was interesting; the extreme muscular debility, the diseased state of the bones, the general want of development in the bodily organs, all would lead one to infer a want of structural development, or *quality*, in the brain-substance. It is true that the microscope did not detect anything abnormal in the cells or fibres of the grey or white matter, nor did the chemist discover any departure from, or want in, the most important constituents of the brain; but, notwithstanding all this, it is highly probable that some *qualitative* excellence was wanting; it is at least certain that the non-detection of such abnormality proves nothing—what microscopist or what chemist, for example, could describe the nature of the difference between two muscles, the one of which was in tone, and the other out of tone, other things at the same time remaining equal? It is impossible indeed to avoid the impression that the want of *quality*, traceable throughout the body, existed also in the brain, although we are not able to say precisely in what the quality was wanting[1].

Another point necessary to dwell upon for a moment is the proportion which existed between different parts of the entire encephalon. In spite of the deficiencies in certain parts of the cerebellum, it has been seen that it bore a higher proportion to the cerebrum than is the case in healthy brains; it was not absolutely heavier (indeed it was notably lighter) than ordinary cerebella, but still it was proportionately heavier than it is in healthy brains. This is probably to be explained by attributing a want of normal development, during the first year or two of infancy, to the frontal lobes, while the occipital lobes and cerebellum continued to grow up to puberty; the character of the brain bears out this hypothesis, for although the frontal lobes were not, *per se*, notably ill-developed, it was evident, from the forward position of the fissure of Rolando, that they had not developed *pari passu* with the hinder parts of the brain. The external appearance of the skull too conveyed this idea during life; for, while the forehead was very small and childlike, the posterior portion of the head was unusually wide. The last feature of importance to be noticed is the anatomical arrangement by which the right occipital lobe was almost completely separated from the parietal lobe. I do not desire to foist any physiological theorem on to this anatomical peculiarity, I only wish to draw attention to it. It will be for future observation to determine how far such a severance is productive of a want of harmony between volition and locomotion, or indeed between volition and action of any kind.

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[1] Some interesting statistical tables of the relation between the mental and bodily conditions in idiots and the insane is to be found in Dr Guggenbuhl's work, *Die Heilung und Verhütung des Cretinismus*, 1853; and in Dr Howe's supplement to the *Report of the Massachusetts Commissioners into the condition of the Idiots of the Commonwealth*, 1858.

CONTRIBUTION TO THE ANATOMY OF THE SHOULDER OF BIRDS. By J. YOUNG, M.D., *Professor of Natural History in the University, Glasgow.*

THE shoulder-girdle of the bird has two articulations more than occur in the mammal, namely the coraco-scapular and coraco-sternal. While therefore the humerus has its movements more restricted in the bird than in man, these two articulations increase largely the variations of the angle which the plane of the wing makes with that of the trunk.

The movements at the coraco-sternal joint are antero-posterior and lateral: they are effected by special muscles, as well as by those which pass from the sternum, or coracoid, to the arm or ribs. The special muscles are lodged in the depression, on the surface of the anterior lateral process of the sternum. The external muscle arises from the greater part of the boundary of the depression and the adjacent surface, and is attached to the posterior margin of the coracoid. The internal muscle arises from the anterior margin of the sternum and the adjacent surface of the depression, and is attached to the upper face of the coracoid in its posterior half. More or fewer of the fibres of the internal muscle pass to the tendon of the external, but the origin of the two are always distinct, and the planes of their fibres are dissimilar; so that even when so intimately united as in the Green Woodpecker and the great Goatsucker, this divergence is very distinct. The action of these muscles is to divaricate the coracoids, and to depress the head of these bones, thereby rendering the axis of the glenoid cavity more vertical. The internal muscle reaches as far as the point of attachment of the long slip, sometimes found as a separate part of the *coraco-brachialis brevis*, and the fibres sometimes intermingle; but even in the Carrion Crow, where such blending frequently occurs, it is not found in every specimen, nor even on both sides of the same bird. Nor has the *coraco-sternalis internus* anything to do with the *coraco-brachialis longus*, whose origin is entirely from the inferior face of the bone, whether from the coracoid alone, as in the Oriole, or from that and the sternum, as in the Swan, in which there is only one muscular belly, while in *Larus tridactylus* the sternal and coracoid portions only unite near their insertion. It is further frequently said, that the *coraco-sternalis* (*externus*) arises from the anterior sternal ribs: this I have found only in the Swan, and even there it amounts only to a partial second origin. There is in fact confusion between this secondary origin and a very distinct muscle, the equivalent, on the outside of the ribs, of the *triangularis sterni*, on the inside. Of this external muscle the first slip—that from the top of the lateral process of the sternum to the angle of the first rib—is always present, more or less recognisable by the different direction of the fibres; those of the inner muscle passing to the junction of the sternal and vertebral ribs, those of the outer not passing so far. Where the external *triangularis* is well developed, as in *Larus*, the bundles pass to four ribs; in the Swan only to two. In a young *Larus* the first slip was interrupted by a thin rod of bone, the representative of a sternal rib, which was loosely attached to the lateral process of the sternum: in the great Goatsucker a tendinous slip occupies a corresponding position. This external *triangularis* is not constant, and its absence, as in the Lapwing and Woodpecker, is associated with a high development of the external oblique muscle of the abdomen.

The structure of the *pectoralis major*, the principal rotator of the humerus, is such that the movement, necessarily a laborious one, is performed, so to speak, by relays of muscle, and the last part of the movement is even more energetic than the first. Thus, in the Heron, the anterior third overlaps considerably the middle portion of the muscle along the sternal crest, and the tendon which lies between the middle and posterior divisions affords attachment to the fibres of the latter, so that each portion provides a fixed point on which the following one may act. The fibres which arise from the posterior part of the sternal surface do not converge to the humerus, but spread out on the under surface of the muscle. By this arrangement, apart from the dynamical advantages, the nerve is protected from pressure;

since the more energetic the contraction, the larger is the opening by which it enters the deep face of the muscle. The antagonistic rotator, the *pectoralis medius* or *subclavius*, gains great power by the spiral which it describes from its origin to its humeral attachment.

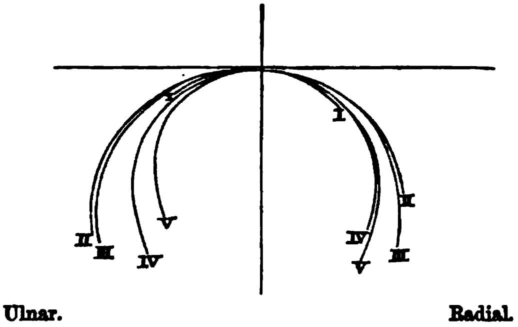
But this rotation is only guided by muscles. The humerus itself is so constructed that rotation is a necessity, and that, further, the rotatory movement yields, and can yield, no other result than such inclination of the wing to the horizon as Pettigrew has found to be the normal one in flight. Marey, in working out the figure of eight, which Pettigrew had previously demonstrated to be the typical form in the muscular arrangement of hollow organs, says that the form of the shoulder-joint *permits* of the appropriate movement, which he everywhere treats as the work of the muscles. Now the form of the humeral articular surface is such that the pull of the great pectoral is much greater than would be required if rotation of the axis of the humerus were alone necessary. The surface is divisible into three areas: a ridge (if I may use such a word for the line of junction of two dissimilar curves) passes from the upper and front part of the articular head, obliquely downwards and inwards, so as to form an angle of 80° with the long axis of the head, and of the condyles at the inferior end of the bone. To the outer side lies a helicoid surface, which dips very suddenly into the bicipital groove. To the inner side, the upper two-thirds of the articular surface is the segment of a very large circle, the plane of whose diameter is at right angles to that of the bone: the inferior third is a small segment of a large circle, whose diameter plane is at 45° to that of the bone; this surface likewise dips abruptly on to the general surface of the bone. The helicoid surface travels on the coraco-scapular ligament by what I have called the ridge, and the rotation of the humerus involves the partial pronation of the limb, without muscular aid at all. In flexion, contrariwise, the movement is reversed, apart from muscular pull. But both *pectoralis major* and *p. medius* act on the long handles of the levers, the salient crests: both have to deal with rotation, but the size of the larger muscle has reference, besides other things, to the curve which the shaft of the bone makes in the air. To depress the bone when the shaft is at the summit of its curve is the duty of the most posterior fibres of the muscle. The *p. medius*, on the other hand, is too small to act as an efficient elevator of the limb, but its size is quite sufficient, considering the advantage which its spiral course gives it, to undo the curve described by the humerus in the forward and downward stroke of flight.

Martius, in treating of the torsion of the humerus, says, that in man it has travelled through 180°, in birds 90°. But if the axis of the articular surface is identical in both bones, relatively to the axis of the condyles, the torsion must be equal. The accompanying figures were drawn for the purpose of showing that the ridge of the bird's humerus occurs also in man. The difficulty of representing on a flat surface the details of the curves, is only partly overcome by the nature printing in the accompanying figures. The head of the humerus was sliced at equal distances, parallel to, and at right angles to, the axis of the condyles, and the outlines of the slices traced on paper. From the comparison of these figures it becomes evident that the rounded surface is not hemispherical, but is made up of the segments of two circles, that with the larger radius being on the side of flexion (the anterior in man), that with the smaller, on the side of extension (or posterior), and that the line of junction of these two is not in a vertical line, but slightly inclined from above, and in front downwards and backwards, in the same relative direction as in the bird, and at 25° to 30° inclination to the axis of the condyles. The steep faces, which in the bird give to the close of flexion and extension something like a jerk, are not found in man; but the spiral movement is distinct enough in the pronation of the hand, when the limb is laid across the chest. Thus even in the details of a single joint the unity of plan of the vertebrates is curiously illustrated, and the deviation from that plan asserted by Martius appears not to exist, the torsion in mammals, reptiles, and birds being alike.

The movements of the glenoid cavity I have not yet examined experimentally with sufficient care. The rarity of allusions to the mobility of the joint is to be explained by the study of skeletons, in which the amount of mobility is no longer recognisable. But in the Goatsucker I have found that the extreme possible divergence of the scapula on the coracoid is 27°, the average angle from the centre of the glenoid to the tip of the scapula on one side to the centre of the posterior sternal margin on the other being in the dried skeleton 57°. In the *Cinnyris*, one of the *Nectarinia*, the limit of movement is only 8°, that is 47° as the average, 55° as the extreme. Though my materials are incomplete, it may be worth while to state some of the average measurements of the angle between coraco-sternum and scapula, it being borne in mind that the variations are due to the elevation or depression of the sternum, the scapula being very nearly fixed in its relations to the vertebral column.

Balæatrica pavonina	42°,	Lestris Richardsoni	43°,
Pelican	65°,	Haliætus albicilla	80°,
Macau	52°,	Alca torda	35°.

From specimens stripped of their muscles it would be unsafe to calculate the extreme movement, but the statement of the great range of averages—35°—80°, may induce some one with better opportunities than I possess to carry on the investigation. Those who delight in special adaptations have in the humerus an imperfect example. There are other joints showing still more remarkable mechanical results, and with these I am at present engaged. The anatomical data for reasonings regarding the mechanism of progression have acquired fresh interest of late years, and it is only just for me to acknowledge the assistance which Dr Pettigrew, by his published papers and oral communications, has rendered me in studying a subject which in this country he has made peculiarly his own.


I
II
III
IV
V
I
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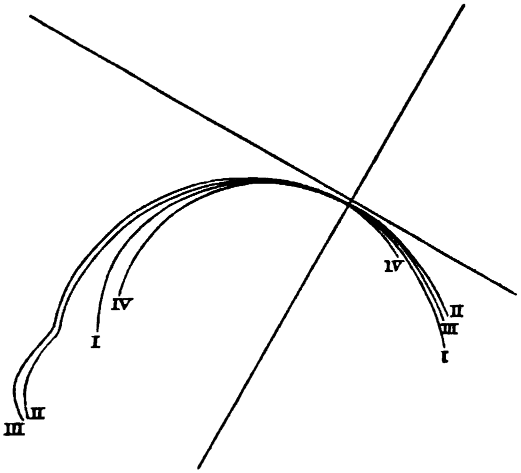
V
Ulnar.
Radial.

Profiles of transverse vertical slices of head of Humerus (human). I. Section next abduction side of bone; V. that on adduction side.


IV
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IV
I
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Profiles of longitudinal vertical slices. I. Slice next radial side; IV. that next ulnar.

CONTRIBUTIONS TO THE ANATOMY OF THE INDIAN ELEPHANT[1]. Part I., THE THORACIC VISCERA. By MORRISON WATSON, M.D., *Demonstrator of Anatomy, University of Edinburgh*[2]. Plate VI.

OWING to the kindness of Professor Turner, I have recently had an opportunity of dissecting the thoracic viscera of an Indian Elephant (*Elephas Indicus*), and the results of this examination I now venture to make public, not so much with the idea that I shall be able to communicate much that is altogether new, but rather, by adding to the descriptions already published, which differ in many points from one another, that of the individual which I have examined, and so clear up some points in the anatomy of an animal which we too seldom have an opportunity of dissecting. At the same time I hope to be able to call attention to certain arrangements, which, so far as I am aware, have, up to the present time escaped observation, and which may therefore prove not altogether uninteresting.

The thoracic portion of the digestive, circulatory, and respiratory organs will be considered consecutively.

DIGESTIVE.

It has long been known that both species of elephant have the power of withdrawing water, stored within the cavities of the stomach, by means of the trunk inserted into the mouth. Sir Emerson Tennent says[3]: "I have elsewhere described the occurrence to which I was myself a witness, of elephants inserting their proboscis in their mouths, and withdrawing gallons of water, which could only have been contained in the receptacle figured by Camper and Home, and of which the true uses were discerned by the clear intellect of Professor Owen." I was not, till very recently, aware that a similar observation as to the remarkable habit of the elephant, had been made by the author of the *Ayeen Akberry*, in his account of the *Feel Kaneh*, or elephant stables of the Emperor Akbar, in which he says: "An elephant frequently with his trunk takes water out of his stomach and sprinkles himself with it, and it is not in the least offensive." The means by which this is effected Tennent believed to lie in the presence of a muscle described by the late Prof. Harrison of Dublin, which is referred to as follows in the work already quoted[1]. Dr Harrison in the course of his examination of the thoracic viscera, observed that an unusually close connection existed between the trachea and œsophagus, which he found to depend on a muscle unnoticed by any previous anatomist, connecting the back of the former with the fore part of the latter, along which the fibres descend, and can be distinctly traced to the cardiac orifice of the stomach. Imperfectly acquainted with the habits and functions of the elephant in a state of nature, Dr Harrison found it difficult to pronounce as to the use of this very peculiar structure; but looking to the intimate connection between the mechanism concerned in the functions of respiration and deglutition, and seeing that the proboscis served in a double capacity as an instrument of voice and an organ for the prehension of food, he ventured to express the opinion that this muscle, viewing its attachment to the trachea, might either have some influence in raising the diaphragm, and thereby assisting in expiration, "*or that it might raise the cardiac orifice of the stomach, and so aid this organ to regurgitate a portion of its contents into the œsophagus*[2]." Unfortunately, however, for this theory, no trace whatever of the trachea-œsophageal muscle was to be found in the specimen I examined; and, as no mention is made of it by any other anatomist, we must, I think, conclude that the muscle was only *exceptionally* present in Harrison's elephant (which is also the case with a corresponding muscle in the human subject[3]), as it is hardly probable, supposing the function alluded to to depend exclusively on the existence of such an arrangement, that the muscle should be present in one specimen and absent in another.

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[1] The viscera of this elephant formed part of the collection of the late Professor Goodsir, purchased after his decease by the University. The animal was bought from a travelling menagerie by Mr Goodsir in 1856.—W. T.

[2] An abstract of this Paper was read before Section D at the Edinburgh Meeting of the British Association for the Advancement of Science, August, 1871.

[3] *Ceylon*, II. 316.

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[1] *Ib.* II. 314.

[2] *Proc. Roy. Irish Acad.* IV. 133.

[3] Vide Henle, *Anatomie des Menschen*, Band II. p. 151.

The muscular fibres of the œsophagus are distinctly striated even down to the œsophageal opening in the diaphragm, and are arranged in two layers, an external, the fibres of which are distinctly longitudinal in direction, and an internal, which consists of two sets of spiral fibres, one of which passes from right to left, whilst the other passes in the opposite direction, and thus gives rise to a decussation of the fibres at all points. It is thus to be observed that the arrangement of the fibres differs materially from that described by Prof. Rutherford in the gullet of the ruminant[1].

With reference, therefore, to the regurgitation of water, we must, I think, conclude that, in the absence of any peculiarity in the stomach to account for it, in all probability it depends, as Flourens has shown to be the case, in the physiological regurgitation of the ruminant, and Magendie in the pathological regurgitation of other animals, on the action of the diaphragm and abdominal muscles.

Thoracic duct. This vessel presents the usual arrangement as far as its relations are concerned. At the posterior extremity of the thorax it has a diameter equal to that of a goose-quill, whilst towards its termination it has reached the size of the axillary artery of the human subject. No appearance of the reservoir of Pecquet, which is described in the *Encyclopédie Méthodique*[2], as being placed opposite the third dorsal vertebra, and extending for a distance of several inches was to be seen, the canal being of uniform diameter throughout. A single pair of valves was placed about two inches behind the spot where the vena azygos turns downwards to open into the right anterior cava, the presence of such being altogether denied in the article just quoted.

ORGANS OF CIRCULATION.

Pericardium. Fig. 1. The description of this viscus will be better understood after a few words concerning the diaphragm. As this muscle had been removed along with the viscera from the cavity of the thorax, and consequently considerably injured before I commenced the dissection, the description is not so perfect as might otherwise have been the case.

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[1] *Journal of Linnean Society*, VIII.

[2] *Encyclopédie Méthodique*, Article Pachydermes.

The greater portion of the diaphragm was occupied by the central tendon, from the margin of which the muscular fibres passed off to their attachment to the circumference of the thorax. These two parts differed materially from one another, for whilst the central tendon was very thick and strong, the muscular portion of the septum, on the other hand, was thin, and the bundles easily separated. An arrangement, however, to strengthen this deficiency was present, consisting of two plates of yellow elastic tissue, one covering each of the surfaces of the muscular portion of the diaphragm. Both of these plates of elastic tissue passed imperceptibly into the substance of the central tendon and there lost themselves. The anterior plate differed from the posterior in this,—that, whilst the posterior plate covered every part of the muscular portion of the diaphragm, the anterior was confined to that part of it which came into relation with the base of the pericardium, and shaded off beyond this region to the left side into a muscular fascia of considerable strength, and composed of fibrous tissue, whilst to the right, owing to the diaphragm having been cut, I could not follow it to its termination. This much however is to be said, that a considerable admixture of fibrous with the yellow elastic tissue having already taken place, seemed to imply that on the right, as on the left side, this elastic plate gradually shaded off into a fibrous tissue. If this supposition be correct, then we must regard the anterior elastic plate as being connected physiologically with the pericardium, and not with the diaphragm. The probability of this view will be increased when the attachment of the pericardium to the diaphragm is considered.

John Hunter[1] states that "The pericardium adheres to the diaphragm nearly as in the human, but not so closely and firmly;" but a more correct description would be that it forms an intermediate stage between the completely free pericardium as described by Prof. Turner in the walrus[2], and the closely adherent human pericardium. Its posterior surface is smooth, and rests against the anterior surface of the tendinous portion of the diaphragm. It is not, however, attached to this as in man; but the corresponding surfaces of the diaphragm and pericardium being smooth, evidently permit a considerable amount of motion between the opposed surfaces. This motion, however, must be limited by the presence of two stout bands of yellow elastic tissue, which become continuous with the fibrous substance of the pericardium at its posterior extremity. These two bands are flattened from above downwards, and measure each about an inch in breadth. They are separated from one another at their attachment to the pericardium by an interval of about three inches. From this attachment they diverge from one another, passing backwards and downwards and finally become continuous with, and lost in the elastic plate already described as covering a portion of the anterior surface of the diaphragm. It is a fact worthy of notice that the pericardiac band of the right side was entirely composed of that peculiar striated form of yellow elastic tissue which, so far as I am aware, has only once before been described, and that in the ligamentum nuchæ of the giraffe by Mr Quekett[1]. In the left band, as well as in the plate into which the bands expanded, the elastic tissue presented the usual appearance. This mode of attachment of the pericardium to the diaphragm in the elephant seems up to this time to have been overlooked, the nearest approach to an accurate description of it having been made by MM. Vulpian and Philipeaux[2], who say: "Au sommet du cœur le péricarde se termine en pointe obtuse, et se continue directement en ce point avec un fort cordon fibreux qui par son autre extrémité va s'insérer au centre phrénique du diaphragme." This description, however, is incomplete, though nearer the truth than those given by other anatomists. As regards the anterior attachment of the pericardium nothing need be said, farther than that it becomes continuous with the outer coat of the ascending and transverse parts of the arch of the aorta.

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[1] *Essays and Observations* by Owen, II. 172.

[2] *Journal of Anatomy and Physiology*, November, 1870.

Heart. With regard to the external configuration of this organ the reader may be referred to the very excellent description of MM. Vulpian and Philipeaux already noticed. The only point to which they have omitted to give prominence, being the distinct bifidity of the apex of the organ, a fact which corroborated the statement of Ælian, Stukeley[1], and Mayer[2]. This bifidity of the heart is interesting when taken in connection with the singular and much more pronounced separation of the ventricles in the dugong and manatee, and its occasional occurrence in the porpoise. No trace of an os cordis was to be found in the wall of the heart. The walls of the cavities in general are much thinner than one would expect in so large an animal; they are however, especially on the right side of the heart, extremely elastic.

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[1] *Histological Catalogue*, I. 89.

[2] *Ann. des Sc. Nat. Zoologie*, 1856, Vol. v.

On opening into the cavity of the right auricle (fig. 2), five distinct openings were seen, viz. those of three venæ cavæ, two anterior—right and left—and one posterior; that of a single coronary vein; and that of the ventricle. At the mouth of each of these openings was placed a valve, with the exception of that of the coronary vein, which lay under cover of a pectinate muscle. The valve at the mouth of the posterior cava—the Eustachian—was of large size, and arranged in the usual manner. That at the mouth of the right anterior cava was peculiar. Taking its rise from the inner aspect of the opening it wound round the *upper* margin, and finally passing backward became attached to the outer wall of the auricle close to the point of entrance of the posterior cava. This description precisely corresponds with that given by Vulpian and Philipeaux, with this exception, that in their specimen the valve passed round the *lower* margin of the caval opening instead of the upper. It is remarkable that their description of the valve corresponds exactly with that given by Prof. Turner[3] of one which he met with as a very rare variation in the human subject—a fact not without interest to those who believe "that man still bears in his bodily frame the indelible stamp of his lowly origin." At the mouth of the left anterior cava was situated a small fenestrated valve formed by a duplication of the endocardium, which is not generally present in those animals possessed of two anterior venæ cavæ, and which I think we must regard as a rudimentary appearance of the Thebesian valve of the higher mammals. Mr Marshall, in his paper on the development of the great veins[1], says: "As to the Thebesian valve it is present in every instance in which the left venous trunk forms a coronary sinus, receiving veins from the heart alone as in man, the monkey, &c.; but amongst those animals which have a left azygos or left superior cava, *it is certainly absent*, as in the calf, hog, &c." The presence of this rudimentary valve in the elephant, therefore, is of interest, not only as establishing a fact not previously known, but also as showing the accuracy of Mr Marshall's observation, that the coronary sinus is the homologue of the lower part of the left anterior cava, since, in the case before us, we not only have the great coronary vein opening into the left anterior vena cava, and defended by the usual pair of valves, but we also have a rudimentary Thebesian valve, which is not usually present in those animals in which the entire left duct of Cuvier is persistent. The fourth opening was that of the anterior coronary vein, which opened on the right wall of the auricle, and, as already stated, was not defended by valves. Vulpian and Philipeaux describe a third coronary vein as opening by a distinct orifice into the auricle, but this was not the case in the present specimen. The right auriculo-ventricular opening was guarded by the tricuspid valve, which however was provided with a small additional cusp placed between the cusps which correspond with the anterior and internal cusps of human anatomy.

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[1] *Essay towards the Anatomy of the Elephant*, Lond. 1723.
[2] *Nova acta Acad. Cæs. Leo-Car.* Vol. XXII.
[3] *Proc. Roy. Soc. Edinburgh*, and *Journal of Anatomy*, May, 1869.

The cavity of the left auricle (fig. 3) presented the four openings of the pulmonary veins, two of which were derived from each lung. Vulpian and Philipeaux describe only two openings in connection with this auricle, a statement difficult to reconcile with the dissection of the present specimen. In front of these openings was placed a valvular structure, which however (by reason of its small size) could not have been effective in preventing the regurgitation of blood into the veins. It arose from the anterior portion of the auricle, and passing down in front of the openings was inserted posteriorly into the anterior raised margin of the fossa ovalis, which was well defined on this, as on the right side, by several tendinous cords. The relation of this valve to the openings of the pulmonary veins was similar to that of the valve of the right superior cava to its opening. This valve does not seem to have been previously recognised. The mitral valve was composed of three distinct cusps, the third small cusp being situated between the inner extremities of the cusps which correspond with the larger anterior and posterior cusps of human anatomy.

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[1] *Phil. Trans.* Part 1, 1850.

The ventricular cavities presented nothing remarkable, and I may refer those desirous of having a full description of them to the memoir by MM. Vulpian and Philipeaux already quoted.

Pulmonary artery. This vessel entirely concealed the ascending part of the arch of the aorta from below, and presented three well marked dilatations externally, which corresponded to the position of the sinuses of Valsalva. Passing forwards and to the right it divided in the concavity of the aortic arch into its two branches, one of which passed to each lung. The ductus arteriosus was attached not to the left branch of the pulmonary artery, as in the human subject, but to the *trunk* of that vessel, three inches behind its point of bifurcation. In front it was attached to the concavity of the aortic arch, just beyond the place of origin of the left subclavian artery. The small azygos lobe of the right lung did not receive any separate branch from the pulmonary artery before it entered the substance of that lung.

Pulmonary veins. These were two in number on each side; the anterior of which was formed close to the hilum pulmonis by the union of several branches derived from the apical lobes of the corresponding lung; whilst the posterior was derived from the posterior or basal part of the lung of its own side; but the vein of the right side received in addition a branch of considerable size from the azygos lobe of this lung, which opened into it immediately before it entered the auricle. These four veins all opened by distinct orifices into the left auricle close to one another.

Coronary arteries. According to Camper[1] there is but a single coronary artery, which shortly after bifurcates so as to supply the usual branches to the heart. In the present dissection, as in those of Vulpian and Mayer, there were two arteries, which were distributed in all respects in the usual manner to the substance of the heart.

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[1] *Description anatomique d'un éléphant mâle.*

With regard to the number of branches given off from the arch of the aorta there is a difference of statement. For whilst Cuvier[1] and Mayer[2] assert that there are *three* trunks given off, viz. the right subclavian, a trunk common to the two carotids, and the left subclavian: on the other hand, Hunter[3], Tiedemann, and Vulpian[4], only mention *two*, viz. 1st, the innominate, which gives off the right subclavian, and the two carotids; and 2nd, the left subclavian. In the present dissection the arrangement was in accordance with the statement of the authors last mentioned (fig. 1). In addition, however, the trunk of the inferior thyroid artery was given off from the point of separation of the two common carotids, a point which Mayer was the first to notice, although, from the fact of Camper having omitted to mention it, he seems doubtful whether it was not to be set down as a variation in his specimen. None of the other authors quoted make mention of this artery. This point is interesting as showing in one of the lower animals a condition which only occurs exceptionally in the human subject, that is, the presence of an arteria thyroidea ima coming off from the trunk of the innominate.

Anterior venæ cavæ.—Each was formed by the junction of *three* large trunks a short distance in front of the arch of the subclavian artery. Of these, one came from the outside, a second came from the direction of the middle line, whilst an intermediate one passed directly backwards. The vena cava of each side, thus formed, passed directly backwards, receiving in its course several smaller veins, one of which was the trunk formed by the union of the companion veins of the mammary artery, and finally opened into the right auricle. In addition to these the right anterior cava received the azygos vein immediately before piercing the pericardium. There was no trace of a small or left azygos vein: the posterior cava immediately after piercing the diaphragm opened into the auricle.

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[1] *Leçons d'anatomie comparée*, Paris, 1802.

[2] *Nov. Act. Acad. Cæs. Leo-Car.* Vol. XXII.

[3] *Essays and Observations* by Owen.

[4] *Ann. Sc. Nat.* Vol. V.

Coronary veins.—These are two in number, a great, and small. The great coronary vein commenced toward the apex of the heart by the union of several branches, the trunk formed by which lay in the anterior ventricular groove. It then turned to the left along the left auriculo-ventricular groove, received in this course a large vein from the posterior-ventricular groove, and opened finally into the left anterior vena cava, a short distance from its termination in the auricle. A pair of valves guarded the entrance into the cava.

The small coronary vein, corresponding to the small anterior vein of Galen of human anatomy, commenced by the union of a number of small twigs toward the left side of the base of the right ventricle. It then passed from left to right along the right auriculo-ventricular groove, and opened into the right auricle by a distinct opening which was not guarded by any valve. Vulpian and Philipeaux described a third coronary vein as opening by a distinct orifice into the auricle, but such was not to be found in the present dissection.

RESPIRATORY SYSTEM.

Trachea. This tube, so far as it lay in the cavity of the thorax, consisted of twelve rings, which were all incomplete behind. These rings presented a peculiarity which, so far as I am aware, has not been observed in the trachea of any other animal; that is, the subdivision of the different rings into distinct segments by means of distinct synovial joints. These joints were each enclosed in a distinct capsule, and presented all the characters of perfect articulations (fig. 4). The number of these articulations in any given ring varied, as many as three being found in a single ring; in others, only two or one, and in others none at all. The same peculiarity manifested itself in the bronchial cartilages. Mr Bishop[1], in his reference to the trachea of the elephant, says, "Trachea thirty rings, which are often partially subdivided." Whether this applies to the peculiarity mentioned, or whether it refers only to that incomplete formation of the separate rings, so common in many animals, I am at a loss to determine, as beyond the statement quoted he makes no further reference to the subject.

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[1] *Cyclopædia of Anatomy*, article Voice.

In addition to and internal to the rings, the trachea presented a strong lining of yellow elastic tissue, the fibres of which were longitudinal in direction. This lining passed uninterruptedly from the trachea into the bronchial tubes. Resting directly against this elastic plate was the tracheal mucous membrane, which was thrown into distinct longitudinal folds or rugæ (fig. 5).

The interval posteriorly between the ends of the rings, in addition to the structures just mentioned, was completed by two distinct layers of involuntary muscle. One of these, the more superficial, passed directly across the interval so as to be attached to the extremities of the rings of the trachea. The deeper set arose from the V-shaped projection of the last tracheal ring, the central fibres passing vertically upwards beneath the transverse fibres of the superficial layer, the lateral bundles assuming a more and more transverse direction, so that the most external of these formed the commencement of the series which filled up the interval between the extremities of the bronchial cartilages.

Bronchi. The right bronchus consisted of eight, the left of six rings. In addition to these, however, there were several small cartilaginous nodules of small size representing rudimentary rings. No accessory bronchus such as is so common among the ruminants was met with; the azygos lobe of the right lung receiving its air-tube from the right bronchus after it had entered the substance of the lung.

Lungs. Each of these presented an elongated oval form, the length being about twice the breadth. Only two surfaces are to be distinguished in each, a dorsal and a ventral; or, more properly speaking, an external and internal. There was thus no distinct diaphragmatic surface to be recognised, as in the human subject; the base of the lung, on account of the peculiarly elongated condition of the thorax dorsally, being continuous with the ventral surface, and being wedged in, as it were, between the diaphragm and the upper wall of the thorax. The line of junction of the two surfaces thus gave rise to the margin of the lung, which was marked externally with distinct marginal notches similar to those described by Owen[1] in the lung of the Rhinoceros. The hilum of the lung was situated on its internal surface at the junction of the anterior with the middle third of its length. The substance of each lung was divided into a number of lobes by processes of a lax connective tissue, which could be easily torn so as to separate the lobes. These rudimentary lobes were much more numerous towards the apex than at the opposite extremity of the organ, and they corresponded exactly in number and form in the lung of each side. The only difference in the two lungs consisted in the possession by the right of a small quadrangular azygos lobe which, connected to the organ immediately below the hilum, projected transversely towards the left, lying between the vena cava inferior and the anterior surface of the diaphragm. Vulpian and Philipeaux describe three distinct lobes in the right lung, and none in the left. This, however, was certainly not the case in the present dissection. The arrangement of the pleural sacs could not be determined on account of their lacerated condition. This membrane, however, did not separate the lobes from one another, but passed continuously over the surface of the lung. The pleura were devoid of all trace of yellow elastic tissue; but upon stripping them off their respective lungs, each of these last was found to be be invested as far forward as the hilum with a thick covering of yellow elastic tissue, which gradually thinned off towards the apex, although it could be traced as a separable membrane over the entire surface of the lung. This investment is much thinner on the internal than on the external surface. This covering towards the posterior extremity of the lung was almost entirely composed of yellow elastic tissue, although containing a slight admixture of ordinary fibrous tissue, but on passing forward to the front of the lung, the quantity of the latter increased so that at the apex the membrane now became very thin so as to be almost entirely composed of it.

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[1] *Anatomy of the Vertebrates*, Vol. III.

The bronchi on entering their respective lungs branched into a number of subdivisions, all of which passed to the apical lobes, with a single exception. This, which was the largest of all, passed backwards in order to supply the larger posterior portion of the lung, giving off in its course numerous branches for the supply of the entire organ. The mode of subdivision of the bronchi, however, was not dichotomous, but quite irregular. As regards the structure of the bronchi themselves, upon entering the lung they at once lost all trace of cartilaginous rings, no trace of this tissue being found in any part of their ramifications. Throughout their entire extent the mucous membrane was thrown into folds as already described in the trachea.

This peculiar non-cartilaginous condition of the intra-pulmonic portion of the bronchi has been recognised before in the howling monkey[1], ichneumon[2], and several other animals, but not, so far as I am aware, has it been previously noticed in the elephant.

Upon transverse section under the microscope the bronchi were found to be composed from without inwards, of, first, a layer of strong elastic tissue; second, a circular layer of involuntary muscular fibres; thirdly, a layer of elastic tissue, but of a finer quality than that composing the external coat; and lastly, of the mucous membrane, the minute structure of which could not be satisfactorily investigated on account of the age of the specimen.

EXPLANATION OF FIGURE ON PLATE VI.

Fig. 1. Heart, pericardium and diaphragm. The pericardium has been cut through and partially turned down to shew the great vessels. *a*, Left auricle. *b*, Right auricle. *c*, Pulmonary artery. *d*, Aorta. *e*, Innominate artery, giving off the right subclavian. *f*, Right and left common carotids; *gg*, and the inferior thyroid artery between the latter. *h*, Left subclavian artery. *ii*, Right and left anterior venæ cavæ thrown down. *k*, Pericardium with the two bands *kk*. *l*, Diaphragm. *m*, Anterior elastic lamina.

Fig. 2. Cavity of right auricle. *a*, Mouth of right anterior cava. *b*, Mouth of left anterior cava with rudimentary valve of Thebesius. *c*, Posterior vena cava. *d*, Valve at mouth of right anterior cava. *e*, Eustachian valve.

Fig. 3. Cavity of left auricle. *a*, Mouths of pulmonary veins. *b*, Valve in connection with these.

Fig. 4. View of trachea from the front. *aaa*, Synovial articulations of tracheal rings.

Fig. 5. View of trachea from behind, shewing rugose condition of the mucous membrane (*a*).

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[1] Cuvier, *Leçons d'anatomie comparée*, Tom. IV. p. 311.

[2] *Ibid.* p. 313.

ON THE ACTION OF INORGANIC SUBSTANCES WHEN INTRODUCED DIRECTLY INTO THE BLOOD. By JAMES BLAKE, M.D., F.R.C.S., *San Francisco, California.*

IN the present paper I propose to relate some experiments which have been made by introducing the salts of platinum and of palladium directly into the blood. The manner in which the experiments were conducted was the same as described in former communications (see this *Journal* for May, 1870).

Exp. 1. A dog not very well nourished, weight about 14 lbs.; pressure in the arteries 4 to 4·6 inches; heart's action regular. A solution containing 1 gr. of chloride of platinum in ℥iij of water was injected into the jugular vein; in 12″ the action of the heart quicker, oscillations not more than 0·1 to 0·2 inches; 20″ action of heart irregular, pressure increased to 5·5 inches; 45″ pressure diminishing; at 2′ it was 2 or 2·2 inches, oscillations slight, breathing rather irregular; 5′ inject 2 grs.; no perceptible effect on the heart; in 40″ pressure in the arteries down to 1·25 inches; no expression of pain, animal quiet, although sensation apparently perfect; 2′ no oscillation in the mercury, although the heart could be felt pulsating; respiration suspended for 50″, the animal lying quite still, although sensible; no convulsion, no expression of pain; pressure in arteries 1·5 inches; slight oscillations (about 0·05 inch). After 50″ respiration again commenced and continued quite regular, but rather slow for about 2′; suspended for 1′, and again commenced; 5′ inject 2 grs.; pressure 1 inch; respiration stopped; in 40″ heart's action continuing after respiration had ceased. On opening the thorax the heart was found beating slightly, both cavities contained blood, right much distended; the blood in the right cavities was dark; that in the left was brighter, a dark maroon colour, coagulated imperfectly; lungs anæmic-collapsed.

Exp. 2. Dog weighed about 16 lbs. A solution containing 2 grs. of chloride of platinum was injected into the axillary artery, the pressure being 4 to 5 inches. Immediately violent struggles and expression of pain. On the animal becoming quiet, the pressure was found to have increased 2 inches; 2′ action of heart slower, pressure down to 3·5, respiration suspended; for 30″ animal sensible, no expression of pain; 5′ inject 4 grs., violent struggles; 45″ animal quiet, pressure 9 to 10 inches, heart's action quicker, respiration slow, deep, arrested; at 2′ heart's action continues, pressure 5·5 to 6 inches, one deep respiratory movement after respiration had been suspended; 1′·30″ no farther sign of life, except that the heart continues beating; 8′ after respiration had ceased, the pressure was still 3 inches; slight oscillations from the action of the heart perceptible. On opening the thorax the heart was found contracting feebly; both cavities contained blood, which was dark in the right, rather brighter in left (dark maroon colour). The lungs were much congested, and there were several ecchymosed spots immediately under the pleura, and in the substance of the lung.

Exp. 3. Injection of chloride of platinum into the veins. General symptoms. A strong healthy dog weighing about 16 lbs. Inject into the jugular vein a solution containing 1 gr. of the salt in three drachms of water. No immediate expression of pain; 45″ staggering with a tendency to fall backwards; 2′ respiration affected longer and deeper, no expression of pain, sensibility perfect; the change in the character of the respiration comes on in paroxysms, lasts about 30″, and then the breathing becomes quite natural; 4′ animal laid down on its side, respiration suspended for 40″, no convulsion, no expression of pain, sensibility unimpaired, took notice of sounds after respiration had been suspended; 45″ respiration again commenced, rather blowing at first, but soon became natural. This total suspension of the respiratory movements recurred four times during the next ten minutes, lasting from 45″ to 1′ 15″, during this time the animal lay quite still, no sign of pain, or even uneasiness, although sensibility apparently remained perfect. On one occasion, after respiration had been suspended for 1′ 15″, there was a slight stiffening of the muscles of the legs and of the tail, but nothing like a convulsion; the action of the heart, as felt through the sides of the chest, apparently very weak. Inject 1·5 gr., breathing arrested in 30″; again commenced after being suspended 45″, heart pulsating feebly, respiration finally suspended after 3′. On opening the thorax the heart was found pulsating feebly, and continued irritable for about 10′; both cavities contained blood, the right dark, the left scarlet; it coagulated imperfectly. Lungs rather red, but collapsed perfectly, evidently contained but little blood. Partial contractions of the voluntary muscles were observed some minutes after death.

Salts of Palladium.

Exp. 4. Dog about 20 lbs. Pressure in the arteries before injecting 5 to 8 inches. Inject ½ gr. of chloride of palladium in ½ oz. of water into the jugular vein. In about 12″ action of the heart fluttering, pressure diminished, oscillations less; 2′ respiration deeper and longer, pressure 4 to 4·2; 5′ pressure 3·5 in. inject 1 gr. of the salt; 14″ the pressure in the arteries suddenly fell to 1·5 inches, and no oscillations perceptible, although the heart could be felt beating slightly through the walls of the chest; 3′ respiration arrested. On opening the thorax there were partial movements of the heart, but no regular contraction; both cavities contained blood; that in the right side dark, in the left rather brighter, dark maroon colour, coagulated slowly. Lungs very pale; anæmic; spontaneous contractions of the voluntary muscles were observed 5 minutes after death.

Exp. 5. Dog weighed about 17 lbs. Pressure in the arteries from 4·5 to 6 in. Inject ½ gr. chloride of palladium into the axillary artery; 12″ there was general spasm with suspension of respiration, then violent struggles causing great oscillations in the pressure; 45″ on the animal becoming quiet, the pressure was found to be increased to 12 in., oscillations, 1 in., heart's action quick; but regular respiration almost suspended, one complete respiratory movement about every 45″. This lasted 4′ 30″, and then respiration finally ceased. During this time the pressure in the arteries gradually diminished; but 1′ after respiration had ceased it was 6 in., heart beating regularly. The heart continued beating regularly for 7′ after respiration had ceased; and when its pulsations were no longer perceptible, the pressure in the arteries was still 3·5 in. On opening the thorax the heart was found contracting irregularly, both cavities full of dark blood, lungs congested with ecchymosed spots; the muscles of the leg, through the artery of which the injection was made, continued to contract spontaneously 15′ after death.

Exp. 6. Dog weighed about 14 lbs. It was not confined. Inject ¼ gr. of chloride of palladium into the jugular vein; no expression of pain; no marked symptoms; 2′ animal seems dull, hangs its head, respiration long and deep; after 10′ again inject ¼ gr.; 15″ animal fell backwards, then lay on its side, no convulsion, no expression of pain; after 40″ again rose and walked about, but seemed uncomfortable; 2′ again fell down, respiration very long and slow, passed urine and fæces; 4′ respiration suspended completely for 45″, animal lying quite still, as if dead, but quite sensible, no convulsion. The same thing occurred four times during the next eight minutes, when the respiration was finally stopped. On opening the thorax the heart was contracting irregularly and slightly; the lungs and the blood presented the same appearances as in Exp. 4.

Salts of Iridium.

Exp. 7. Owing to the chlorides of iridium being decomposed by water, the double chloride of iridium and ammonia was used.

Dog strong, healthy, weight 16 lbs. Pressure in the arteries 4 to 5 in. A solution containing about ½ gr. of the salt was injected into the jugular vein; 8″ the pressure in the arteries began to diminish, the heart's action became quicker, oscillations in the mercury slight: 20″ there was an increase in the pressure to 5 in., no expression of pain; the pressure again gradually diminished; at 4′ it was 3·5 in., respiratory movements slower and deep: 10′ inject 1 gr.: 11″ pressure falling rapidly: 30″ pressure 1 in., respiration deep, irregular: 1′ 20″ pressure 0·5 in., no oscillation, respiration intermittent: 3′ 30″ respiration ceased. On opening the thorax the heart was found contracting rhythmically, right cavities much distended with dark blood, left cavities contained blood not so dark, the blood coagulated imperfectly. The lungs were anæmic, collapsed more than usual on the thorax being opened[1].

As regards the proximate cause of the effects that follow the mixing of these substances with the blood, it is evident that even in very small quantities (¼ gr. chloride of palladium) they exert a marked influence on the passage of the blood through the lungs; and in larger doses they completely stop the pulmonary circulation, by causing contraction of the smaller arteries or the capillaries. This is shown by the sudden fall in the pressure in the arteries immediately after the injection of a full dose into the veins, and the presence of scarlet blood in the left cavity, when the heart continues beating sometime after respiration has been arrested. In smaller quantities they pass through the lungs after a few seconds, and an analogous effect is then often exerted on the systemic vessels, the pressure in the arteries becoming increased. This effect, however, on the systemic vessels is much better shown when the salt is injected directly into the arteries, the obstacle to the circulation becoming so great, that the pressure of the blood in the arteries is more than doubled, or equal to a column of mercury of eleven to twelve inches. It is probable that this obstacle to the systemic circulation is caused by the substance producing directly contraction of the smaller vessels or capillaries. In the case of the pulmonary vessels it certainly cannot be due to any effect on the vaso-motor nerves, at least as far as the central organ is concerned, for it so immediately follows the injection, that the salt would not have had time to reach the nervous centres. The anæmic condition of the lungs in cases where a full dose has been used, and when the salt has not even reached the left side of the heart, shows the local action on the blood-vessels. The effusion and ecchymosis in these organs when the substance has been introduced into the arteries, is owing, undoubtedly, to the great backward pressure to which they are subject when the heart is contracting under the pressure of a twelve inch column of mercury. The presence of scarlet blood in the left cavities when the action of the heart has continued some time after respiration has ceased, shows how complete must be the obstruction to the circulation in the lungs. The left cavities are prevented from discharging their blood by the overdisturbed state of the right heart[1].

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[1] Owing to my notes containing the account of other experiments performed with the salts of iridium, and also with those of asmium, having been destroyed, I am unable to furnish the data as to the further action of these substances.

The suspension of the respiratory movements for more than a minute without producing any distress, the animal being perfectly sensible, their renewal and continuance for some time, to be again suspended, and this occurring many times, is certainly a curious phenomenon, and one difficult to reconcile with the accepted theories as to the cause of the respiratory movements, unless, indeed, the presence of the salt in the blood can, to a certain extent, supply the place of oxygen. This hypothesis receives support from the fact, that the heart continues beating so long after respiration had ceased (7 minutes), and this too when the pressure in the arteries was at four inches, or about its normal height. The proximate cause of death, when a moderate quantity of these salts is introduced into the veins, is, undoubtedly, owing to arrest of the respiration; but whether this is caused by their action on the nervous centres, or to their local action on the lung-nerves, it is difficult to say. I believe the latter view the more probable. The sudden cessation of respiration, and the marked nervous symptoms that follow the injection of these salts into the arteries, are owing to the sudden and great pressure that the nervous centres must be subject to when the arterial tension is so rapidly increased. The smallness of the quantity of these salts, which mixed with the blood causes such striking reactions, places them amongst our most powerful reagents: in fact, the chloride of palladium, in its power in modifying the properties of living matter, surpasses every other inorganic compound with which I have experimented. That half a grain of this salt diffused through the whole mass of the blood should give rise to such striking effects shows the excessive delicacy of living substances as reagents for certain inorganic compounds.

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[1] In my earlier experiments with these salts, the sudden fall of the pressure in the arteries, and the presence of scarlet blood in the left cavities of the heart, led me to conclude that they paralysed the heart.

SOME ADDITIONAL VARIATIONS IN THE DISTRIBUTION OF THE NERVES OF THE HUMAN BODY. By PROFESSOR TURNER.

I HAVE on several occasions recorded examples, which have come under my notice in the dissecting room, of variations from the usually described arrangement of the nerves of the human body (*Natural History Review,* 1864: this *Journal, November,* 1866: *Proc. Roy. Soc. London,* 1868). I propose now briefly to note some additional variations which I have met with.

Branches of the 5*th Cranial Nerve.* Left orbit in which the frontal nerve gave origin to a long slender infra-trochlear branch, which passed below the pulley to be distributed along with the infra-trochlear of the nasal.

Right orbit in which the lachrymal branch of the ophthalmic was not seen, but the temporal branch of the orbital branch of the superior maxillary division sent a large branch to the lachrymal gland. On the left side of same subject a small lachrymal nerve was present, but the temporal branch from the superior maxillary, as it lay in relation to the outer wall of the orbit, gave an accessory branch to the gland.

Right side in which gustatory and inferior dental nerves formed one cord until opposite dental foramen, when the dental nerve entered its canal. An additional case to the one described in *Natural History Review,* in which the mylo-hyoid nerve not only supplied its proper muscles, but gave off a branch which pierced the mylo-hyoid muscle to join the gustatory nerve on the distal side of the submaxillary ganglion. A slight modification of this arrangement was seen in another subject in which the right mylo-hyoid nerve passed under cover of the posterior border of the corresponding muscle before it bifurcated, when the muscular branch pierced the mylo-hyoid to supply it and the anterior belly of the digastric. Gaillet has described some closely similar cases.

Branch of Vagus. On left side vagus and hypoglossal were intimately connected as low as posterior belly of digastric.

Here a large funiculus arose from vagus which gave off branches to depressor muscles of larynx, and then, much diminished in size, rejoined the trunk of the vagus a short distance above the 1st rib. In this case the fibres of the descendens noni had obviously accompanied the trunk of the vagus for some distance, and when this branch was given off some fibres proper to the vagus probably accompanied it, which rejoined their trunk lower down in the neck. Similar apparent origins of the descendens noni from vagus have been described by myself and other anatomists.

Posterior Divisions of Spinal Nerves. On right side the external branches of the posterior divisions of the 2nd and 3rd dorsal nerves pierced the vertebral aponeurosis, gave branches to the lower fibres of the rhomboideus major, then pierced that muscle to end in the lower part of the trapezius. On left side the external branch of the posterior division of the 3rd dorsal nerve terminated in the lower fibres of the rhomboideus major. On both sides the rhomboidei also received their proper nerves of supply from the 5th cervical, and the distribution of the spinal accessory to each trapezius was normal.

Anterior Divisions of the Cervical Spinal Nerves. On left side the supra-clavicular cutaneous branch of the cervical plexus passed through a canal in the clavicle in its course to the integument in front of the greater pectoral muscle. Right side of another subject in which the 4th and not the 3rd cervical nerve gave a branch to the levator anguli scapulæ.

Variations in the course of the phrenic nerve and its lowest root of origin are not uncommon. Though this nerve usually enters the thorax in front of the internal mammary artery, sometimes it goes behind. On the left side of one subject it passed in front not only of that artery, but of the subclavian vein (see also Quain's *Arteries*). In one case the root from the 5th cervical passed independently down the anterior surface of the scalenus anticus to join the phrenic at the root of the neck; whilst in another it ran in front of the right subclavian vein, and behind the 1st costal cartilage to join the phrenic close to the origin of the arteria innominata.

The arrangement of the cords and the mode of origin of the branches of the Brachial plexus are subject to very frequent variations, some of which I recorded in my former paper in the *Natural History Review.* Other variations are as follows: more than once I have seen the plexus to possess three, and not two cords, in its original construction: an outer formed by the junction of subdivisions of the 5th, 6th, and 7th cervical nerves; a posterior by the junction of subdivisions of the 5th, 6th, 7th, and 8th, and an inner by the junction of a subdivision of the 8th cervical with the 1st dorsal. In another case the outer cord was formed by junction of subdivisions of 6th and 7th: the posterior by junction of subdivisions of 7th and 8th; the inner by a subdivision of 8th cervical joining the 1st dorsal. The outer cord gave origin to musculo-cutaneous and outer head of median nerves; the posterior to subscapular and musculo-spiral; the inner to ulnar and inner head of median. The nerve of Wrisberg, internal cutaneous, and anterior thoracic, arose directly from 1st dorsal; the supra-scapular from 5th cervical, and the circumflex by the junction of almost equal branches of the 5th and 6th cervical nerves. In another case the brachial plexus had only two cords in the axilla: a posterior, which gave origin to its usual branches; an external, from which arose all the branches which usually spring from the outer and inner cords. The branches for the inner side of the limb passed superficial to the arterial trunk. In another subject the 7th cervical nerve did not join the upper cord of the plexus, but divided into three branches, one passed to the inner, another to the posterior cord, and the third entered directly into the formation of the median nerve. In another subject the outer cord of plexus gave origin to both anterior thoracic nerves, to the outer head of the median, the musculo-cutaneous, and to a long slender branch which crossed obliquely in front of the axillary artery to join the ulnar. In another, the anterior thoracic nerve which supplied the pectoralis minor, arose by two roots, one from inner, the other from outer cord of plexus. In another the left ulnar nerve had two roots, one from inner, and an accessory funiculus from outer cord, which was traced upwards to 7th cervical nerve: it crossed in front of the axillary artery and joined the ulnar opposite the lower edge of the tendon of subscapularis.

Various modifications in the arrangement of the median

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Various modifications in the arrangement of the median and musculo-cutaneous nerves have been described by Hyrtl, Gruber, Gegenbaur, Krause and myself. I may now record a case in which the outer head of the median passed behind the axillary artery, so that the trunk of this nerve was throughout situated on the inner side of the vascular trunk. A case in which the musculo-cutaneous pierced both coraco-brachialis and short head of biceps, whilst the median passed behind the brachial artery. Another in which the inner head of the median passed behind the axillary, whilst the trunk of the nerve went behind the brachial lower down in the limb. A case where the axillary artery gave rise to a large profunda branch, between the two vessels the inner head of the median passed to join the outer. Lower down the limb the nerve went behind the brachial artery. Gruber has noticed that in 100 arms the nerve passed 20 times behind the vessel. A subject in which a very large musculo-cutaneous nerve pierced coraco-brachialis, then gave off a large branch which joined the median, but before doing so a branch to rejoin the musculo-cutaneous lower down in the limb arose from it. After giving off the above large branch the musculo-cutaneous a second time pierced the coraco-brachialis. Another, in which the musculo-cutaneous, after piercing the coraco-brachialis, divided into two branches, one to supply biceps and brachialis anticus and to become the external cutaneous nerve of forearm, the other to join the median, and also to give rise to a branch which joined the external cutaneous 3 inches above the elbow. Another, in which the musculo-cutaneous gave off in middle of upper arm a fine branch, which descended along with brachial artery, and was lost in the deep loose areolar tissue in front of the elbow.

In the *Natural History Review* I described a case in which the teres major derived its nerve from the circumflex, which also supplied the deltoid and teres minor. I have since seen a second case of the same kind: but in it 3 subscapular nerves were also present, two for the subscapularis, one for the latissimus dorsi.

Gruber has recently recorded cases of communication between the median and ulnar nerves in the forearm. In January, 1868, I saw a branch arise from the median in the middle of the left forearm, and pass obliquely downwards and inwards between the flexor muscles of the fingers, to join the ulnar. In the same arm the posterior interosseous nerve did not form the so-called ganglion behind the carpus, but passed down the back of the hand to the cleft between the middle and index, divided there into two branches, which supplied the web, and ran down the adjacent sides of those digits. Another subject, in which the dorsal branch of the ulnar nerve ended in the skin of the inner margin of the hand, and the radial formed the only dorsal nerve for the digits. A case in which the median supplied the 1st, 2nd, and 3rd lumbricales, the ulnar only the 4th.

Anterior Divisions of Lumbar Nerves. A subject in which obturator nerve arose from 2nd, 3rd, and 4th lumbar nerves. Another in which the accessory obturator descended behind the pectineus, and in front of the horizontal ramus of the pubis and the adductor longus, to join the obturator and internal cutaneous nerves at the inner side of the thigh below the insertion of the adductor longus.

Anterior Divisions of Sacral Nerves. Correlated with duplicity of the pyriformis muscle the great sciatic nerve is also subdivided into two parts, one emerges below the pyriformis, the other between its two subdivisions. In a case of this kind I saw the small sciatic also subdivided into two parts, one passed below the muscle, the other between its two halves, to join the lower root, after it had given origin to the long pudendal and cutaneous branches to the inner side of the thigh.

Great variability is displayed in the distribution of the digital nerves to the dorsum of the foot. In my former paper I stated that it largely depended on differences in the number of toes supplied respectively by the anterior tibial and external cutaneous, but further observation has shown me that the external saphenous participates in these variations, as I have several times seen this nerve supply not only the skin of the outer side of the 5th toe, but its inner side, and even send digital branches to the 4th and 3rd toes.

I have not noted here the many variations in relative size exhibited by the different nerves which pass to given cutaneous areas, as all my observations bear out the view I had expressed on this subject in the *Natural History Review.* But I may state further, in connection with a remark made by Mr Darwin in "*the Variations of Animals and Plants under Domestication,*" II. 300, that I believe the difference in size of the nerves passing to a given cutaneous area, to be due to original variation, and not to increased use or action. Further, I may state that variations in the arrangement of the cutaneous nerves, which pass to the dorsum of the hand and foot, are more frequent than in those which supply their opposite aspects; for the palm and sole, which are more especially employed as tactile surfaces, seem to need more precise and constant connection with definite regions in the cerebro-spinal nervous centres than is necessary for the dorsal aspects of the terminal parts of the limbs.

ON SOME POINTS IN THE ANATOMY OF A GREAT FIN-WHALE (*Balænoptera Musculus*). By JOHN STRUTHERS, M.D., *Professor of Anatomy in the University of Aberdeen.* (Plate VII.)

THIS Whale was found dead in the North Sea off Aberdeen, and was towed into Peterhead Bay on 27th June last. I have to thank my friend Dr Jamieson of Peterhead for his kindness and assistance there. At low tide the carcase lay among the rocks on its right side with the belly partly turned up, the head almost quite on its back. The plaited breast at once showed it to be one of the Rorquals. The length, measured along the back was 68 feet, along the side 64 feet. I take the latter as the true length. From the remaining colour, the size of the whalebone and its white colour on the bristly surface, the narrow form of the body and head, the relatively small pectoral fin, the well marked dorsal fin and its position, the thinness of the blubber, and from other characters which will be noticed in the course of the paper, it appears that this Whale presents most nearly the characters given as distinctive of the Razorback, *Balænoptera musculus* (*Physalus antiquorum* of Gray, *Pterobalæna communis* of van Beneden). In some of its osteological characters, however, it will be seen to present variations from these. It was a male, and the state of the vertebræ shows that it was passing from the adolescent to the adult state.

BONY RUDIMENT OF HIND LIMB.—The discovery by Prof. Flower of a nodule of cartilage attached to the pelvic bone in *B. musculus*, which he regards[1] as the representative of the hind limb in this Whale, gave an additional interest to the inquiry as to the existence of this rudiment in Fin-whales. After making the external measurements, I dissected out the pelvic bone on the exposed side, keeping well clear of it on the outer side. In doing so I was in no small degree gratified to feel in my hand a separate bone moving on the pelvic bone. At first it felt as if in a capsule, but on dissection this proved to be only loose fatty tissue. The form and situation of the appendicular bone, and its ligamentous connection, are represented in Fig. 3. In form it is a flattened ovoid, length 2 inches, breadth 1¼, thickness ⅝. Of the length, the inner three-fourths are bony, the outer fourth, as represented in the sketch, is cartilaginous, and from this a fibrous continuation proceeded outwards among the soft parts. The bone lay in the hollow between the iliac and pubic processes of the pelvic bone, about two inches from the former and close to, or even a little overlapping the latter. At the proximal end it was attached by a strong flat triangular ligament which passed back in two chief bands, the external to the iliac process, checking inward motion of the bone across the pubes, the internal reaching obliquely backwards in part upon the ischial process, checking outward motion. Being joined by a thinner part, both together appear as one large triangular ligament attaching the appendicular bone to the under surface of the pelvic bone near the meeting of its three processes, and, therefore, in a position corresponding to the acetabulum. There was no ligament connecting it to the pubic process or other outward connection save the fibrous prolongation already noticed, the distal connections and nature of which it will be interesting to ascertain when an opportunity occurs of following it out among the more distant soft parts.

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[1] *Proc. Zoo. Soc. of London*, Nov. 1865, p. 704.

This observation added to that of Mr Flower may be considered as determining the presence of the rudimentary hind limb in *B. musculus.* In Mr Flower's specimen, also a male and three feet longer than mine, the nodule was cartilaginous, while in mine it was mostly bony, but variation is to be expected in parts so rudimentary. When the Cetacean hind limb was first discovered by Reinhardt in a new-born Greenland Right-whale, the femur was partly ossified while the pelvic bone and tibia were still cartilaginous, but in the full-grown Whale of the same species Eschricht and Reinhardt found an ossified femur 8 inches long and an ossified tibia 4 inches long, the femur with synovial articulation to the pelvic bone at one end, and similarly articulated to the tibia at the other[1]. Some might be disposed to regard these bones as representing the distal rather than the proximal end of the rudimentary limb, but the nomenclature of Eschricht and Reinhardt appears to be the more correct as well as simple. Abandoning the first view of Eschricht that these bones are analogous rather to the marsupial bones of Marsupial animals, they interpreted the two subsidiary bones in the Greenland Right-whale as rudimentary hind legs hidden in the flesh, and as representing the femur and tibia. Transferring this interpretation to the single subsidiary bone which Eschricht found in three fœtuses and one full-grown specimen of the Greenland Humpback, they consider it to represent the femur in that whale. In like manner the cartilage or bone in the Razorback may also be regarded as representing the femur.

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[1] *Memoir on the Greenland Right-whale (Balæna Mysticetus).* Copenhagen, 1861. Ray Society's translation.

THE PELVIC BONE.—The form is seen in the sketch, Fig. 3. The three processes may be termed ischial, pubic, and iliac, following the interpretation of Eschricht and Reinhardt, although they are ossified from one centre. Homologous parts may in one species be developed as outgrowths, in another independently, and may even vary in this respect in the same species, notably so in the case of Cetacean transverse processes, as preparations in my collection show. The homology of the three processes of the bone is at least relationally correct and the nomenclature is convenient. It is a gently curved bone, over 20 inches in direct length (23 with the cartilaginous ends), concavity inwards, depth of curve 2 inches. (*a*) The *Ischial process*, posterior, 9 inches in length, is the thickest, and prismatic except towards the iliac expansion. By its flattened inner surface it attached the crus penis for a length of 6 inches, as indicated in the sketch. Its upper surface presents a long rough depression at and behind the middle. The end is continued by cartilage for an inch. (*b*) The *Pubic process*, anterior and internal, 12 inches in length, is at first flattened like the iliac part, then prismatic along its middle third, and in its distal third flattened in the opposite direction, the surfaces inwards and outwards. It expands a little towards the end which is continued by cartilage for an inch. (*c*) The *Iliac process*, external, short broad and triangular, rises to a blunt summit, which projects 2½ inches beyond the line of the outer margin of the bone, and is 4 inches from the opposite edge of the bone. Breadth at the base 5 inches, close to the summit 1½ inch. The whole bone is much flattened here, thickness ⅝ inch, upper surface convex, under surface concave. The ridge across the back part of the iliac process on the under surface attaches the ligament of the femur. Behind this there are rough depressions.

Near the fore part of the base of the iliac process there is a foramen piercing through the bone, large enough to admit a goose-quill, directed obliquely from the under surface outwards and backwards. In the sketch I have carried the ligament and rudimentary bone a little outwards in order to show the foramen. It was occupied by fat. That this space may have no morphological significance may the more readily be supposed when the mode of development of the bone is considered. But if in comparing the Cetacean innominate bone with that of the quadruped or of man, we consider the ischial and pubic perineal rami to be here greatly elongated, forming the sides of the Cetacean perineal girdle, and the iliac bone (which in its developed state is related to quadrupedal or bipedal support) to be here stunted, then this foramen occupies the position of the obturator foramen in the developed pelvis.

MUSCLES OF THE FINGERS. FLEXORS AND EXTENSORS. In 1865 Prof. Flower observed the presence of muscles in the forearm of a large Fin-whale (*B. musculus*), and directed attention[1] to the importance of having them more fully investigated. These muscles have since been examined in the lesser Fin-whale (*B. rostrata*) on two occasions, by Drs Carte and Macalister of Dublin[2] and by Mr J. B. Perrin[3]. The arrangement of the muscles, as found by these authors, was in several respects different in the two individuals of the same species. I embraced the opportunity of observing these muscles, and as they are very interesting structures, and the large scale of the specimen enabled the various points in their anatomy to be made out distinctly, I have thought it worth while to describe them fully. The arrangement found, besides, differs in several respects from that found by the above-mentioned authors. Their arrangement is represented in Figs. 1 and 2. I sketched them carefully from the dissection, and the artist has reduced them to $\frac{1}{16}$ on the stone.

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[1] *P. Z. S.* 1865, p. 705.
[2] *Trans. Roy. Soc. of London*, 1868.
[3] *P. Z. S.* 1870.

(*a*) *Internal, or palmar, aspect.* There are three muscles on the internal, or flexor, aspect of the forearm. They correspond to the following muscles in man—flexor carpi ulnaris, flexor profundus digitorum, flexor longus pollicis.

1. *Flexor carpi ulnaris.* This muscle arose by a thin fan-shaped fleshy expansion from the olecranon cartilage and ulna near it. Tapering, it ended in a rounded tendon about the thickness of the little finger, which passed straight along the free fatty space between the ulna and the upper edge of the paddle, and, expanding a little, ended by being inserted into the nearest point and some way along the ulnar slope of the pisiform cartilage. Length 2 feet; tendon occupies rather more than half of this and sends an aponeurotic expansion on the fusiform and fan-shaped portions of the fleshy part. In the Pike-whale this muscle was found by Drs Carte and Macalister to be inserted into the fourth metacarpal bone, by Mr Perrin, to the lower end of the ulna. Here its insertion into and termination in the pisiform cartilage is quite distinct. The *Pisiform cartilage* is flattened, 5 inches in length, 3 in breadth, and is movable upon the carpus and ulna. The homology of this cartilage to the pisiform bone, and of this muscle to the flexor carpi ulnaris of man, is striking. This muscle can have little or no action in flexing or abducting the carpus, and the motion of the pisiform is too limited to account for the muscle. It may give tension to the pisiform cartilage as the part which is placed at and maintains the greatest convexity of the thin upper edge of the paddle; it may give resistance to a flexible olecranon for the action of the triceps, or even partially transmit the tension of the triceps to the pisiform; but it seems as if its most likely effect will be, like a string within a curtain, to give resistance to the soft part of the paddle which intervenes between the upper edge of the paddle and the ulna.

2. *Flexor digitorum ulnaris,* answering to the Flexor profundus digitorum of man. It is the largest of the muscles. Fleshy part, length 30 inches; breadth at first 7, diminishing to 2; thickness above middle nearly 2, diminishing distally to 1. Is a single penniform muscle, length of fibres 3 to 4 in. Origins, over total length of 27 in., partly from humerus, ligament of elbow, olecranon, along slope of shaft of ulna, interosseous tis-

sue, and septum between it and next muscle. Form, at first flat and expanded on humerus and at first on ulna, then thick and narrow, and, with next muscle, sunk into interosseous hollow, so that they do not project beyond level of bones. Tendon runs up along ulnar margin and sends a stong aponeurotic expansion over muscle, but first 3 or 4 inches purely fleshy. Where flesh ceases, tendon is 1½ inch broad and about half as thick; gradually expands along distal fifth of forearm to a breadth of 3 inches, where exchange with tendon of next muscle occurs, and finally to breadth of 5 inches, opposite first carpal row, just before it divides into four tendons.

3. *Flexor digitorum radialis.* This muscle corresponds to the Flexor longus pollicis of man, in quadrupeds and quadrumana to the external deep flexor which is in various degrees united with the internal deep flexor. Is about ⅓ bulk of last muscle. Fleshy part, length 21 inches; breadth at first 2, diminishing distally; thickness over 1 inch. Origins, over total length of 18 inches, along proximal ⅔ of radius beginning 4 inches after elbow, from interosseous tissue, and strongly from fibrous septum between it and last muscle. Origin covers at first about ⅓ of breadth of radius, and narrows as it passes along the interosseous hollow. Is a bipenniform muscle, the fibres 2 to 3 inches in length. Tendon sends aponeurosis over distal ⅔ of fleshy belly, and is concealed as a partition in proximal third. Fleshy fibres of this and last muscle cease opposite same point. Tendon 1 inch broad, and ¼ thick.

The *tendons of the two flexors* exchanged fibres in a manner which may be compared to the exchange, when it is complete, between the corresponding muscles in the sole of the human foot. The slip from the ulnar flexor formed more than ⅓ of the tendon to the radial digit; the radial flexor passed mainly to the first digit (which in this four-fingered hand answers to the Index), sending about ⅓ of its bulk as a slip to the ulnar flexor, which went on one side entirely to the next digit, in the other limb also in part to the tendons of the two ulnar digits. The oval slit seen in the sketch existed on one side only. The four tendons separate in the manner shown in the sketch, the two radial 1½ in. earlier than the two ulnar. The tendons of the middle digits and that of the radial digit have no insertion into the metacarpal bones, the hollowed surfaces of which are levelled up by fibrous tissue, which is smoothly grooved to form the floor of the theca. They begin to be inserted into the first joint, or first phalanx, and thereafter are continued to the distal phalanges, gradually diminishing, and are attached to every phalanx, not by one insertion merely but by a close succession of fibrous lamellæ. As the tendons pass along the fingers they give off oblique slips to the joints, giving the appearance of a diamond-shaped expansion at each joint. The tendons of the lateral digits are twice the size, though not twice the breadth, of those of the two middle digits; they pass obliquely, and, before reaching the phalanges, have strong lateral attachments to the first joint, that of the ulnar digit laying hold also of the distal part of the metacarpal bone, thus maintaining their obliquity. The lateral digits have thus the strongest tendons, and they are so attached as to give them a special hold on the margins of the paddle. The middle tendons opposite the metacarpal bones are ¾ inch in breadth, and may be compared to thick leather straps bevellel off at the edges. The tendons lie in thecæ. These begin as soon as the tendons, and fit them, with loose connective tissue between as far as the expansion, after which the separate tendons and their thecæ present smooth synovial surfaces, interrupted on the deep aspect where the insertions commence. The floor of these thecæ on the fingers is formed by masses of fibrous tissue, levelling up the hollows of the phalanges. These pass from cartilage to cartilage much more than from phalanx to phalanx, and while they partly serve as ligaments binding the thick epiphysial cartilages to the bones they serve to fill up the hollows so far, and are remarkable instances of those stratified periosteal thickenings which are seen at various parts of the Cetacean skeleton, the whole periosteum of which appears to be peculiarly thick. The tendons themselves are so extensively connected to the phalanges that they may be regarded as partly ligaments.

No trace was seen of any muscle corresponding to the *Palmaris longus* found by Drs Carte and Macalister, or of the *Flexor sublimis digitorum* found by Mr Perrin, in their dissections of the lesser Fin-whale.

(*b*) *External, or dorsal, aspect.* The extensor communis digitorum alone was present. Fleshy part, length 18 in., being more than half length of forearm; breadth, greatest 3½ in., diminishing at middle to 2½, near tendon to 1¼; thickness about 1 inch. Origins, beginning 2 inches below elbow, from both bones, along narrow part of ulna for 6 in., along radius for 16 and more broadly; deeply from the interosseous fibro-adipose tissue, and superficially, as in man, from a strong aponeurosis which binds it down into the interosseous hollow, this aponeurosis arising as high as the elbow-joint. Also from several fibrous septa which dip into the muscle and give origin to bipenniform bundles. Fibres 2 inches or more in length. Tendon sent thick prolongation over distal half of flesh. Tendon, at first 1¼ in. in breadth, passed along distal ⅜ of forearm, and opposite middle of carpus had expanded to a breadth of 4 inches transversely. From this expansion the four tendons proceeded in the same order as that of the flexors, the tendon to the radial digit first. Unlike the flexor tendons, the extensor tendons to the lateral digits were weaker than those to the two middle digits, but they had the same early marginal insertion, maintaining their oblique position. All of the extensor tendons were attached to the metacarpal bones as well as to the phalanges. As they passed along, diminishing to the distal phalanx, they broke up at each joint, as in man, into three, the middle portion passing straight on while the lateral expansions laid hold of the swollen joint and the phalanx beyond. In addition to these tendons and adhering to them, there were strong fibrous bands passing along the metacarpal bones and phalanges, filling up the hollows as on the palmar aspect.

It may seem at first that these digital muscles, larger than the hamstrings in a muscular man, and with their red healthy fibres indicating activity, must be of considerable importance in the limb, but they are small relatively to the size and condition of the parts on which they act. The whole fleshy mass is not half so bulky as one of the fingers on which they act; and comparing them with the great mass of flesh in the forearm of a man or quadruped, in relation to their digits, we may see how feeble they must be as moving powers. Then there is the comparative inflexibility of the joints, and the farther restriction of motion by the uniform covering of skin and blubber in which the whole is wrapped. It will satisfy any one of this when he finds his whole strength exerted in vain to bend one of these large paddles, except near the tip and along the soft ulnar margin. The length of the fibres composing the muscles shows that there is less than an inch of contraction to spread over a series of joints extending some three feet in length. The total functional result cannot be more than to give some rigidity or resistance to the joints, the tendons serving very much as ligaments which the muscles will help to tighten, and we see the flexors, which will be used in the chief stroke of the paddle, stronger than the extensors, especially on the lateral digits. These muscles must, therefore, be regarded as rudimentary structures, existing through their mammalian affinities and maintained by the stimulus of a low function. I have seldom if ever contemplated a dissection which impressed me more than that of these muscles when first displayed. Within an externally unyielding fin, great red muscles and their tendons stretching along the white bones, the obvious correspondence to structures in the human limb, their vast size, and yet rudimentary[1].

THE RIBS. (a) *Sixteenth pair of Ribs.* Among the Fin-whales *B. rostrata* has 11 pairs of ribs, *B. musculus* 15, *B. Sibbaldii* 15 or 16. As a developed 16th pair in Sibbaldius appears to have been seen only in the Hull skeleton, it is most likely an individual variety. As far as observations go *B. musculus* shows a tendency to diminution rather than increase of ribs, the 15th rib being sometimes found much reduced and placed far from the spine, but a small 16th rib attached to the first lumbar transverse process has also been seen[1]. The variety which I found in this Razorback was the occurrence of a 16th pair of ribs suspended in the position in which a reduced 15th pair is sometimes found, far from the spine. The right 30 inches in length, the left 22, each end prolonged for an inch by cartilage. In form, the lower ⅔ vary from 1½ to 1¾ inch in breadth, the upper ⅓ undulating and tapering to a narrow point. Neighbouring part of 15th ribs 2 to 2¼ inches in breadth. They were suspended opposite the distal part of the 15th ribs; the soft parts connecting the right were already severed, but the left projected six inches beyond the end of the 15th rib. The intercostal space was 2 to 2½ inches in breadth, and was occupied by a well-marked external intercostal muscle, without trace of an internal intercostal. As it is apt to be overlooked, a suspended additional rib may possibly be not unfrequent in Cetacea[2]. The 15th ribs are well developed, length 72 inches presenting the peculiar sinuous and twisted form described by Dr Murie (*P. Z. S.* 1865) in his account of the Rosherville skeleton. The longest rib measures 114 inches along the outer edge, straight 87.

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[1] A few days after I had given the above account of these muscles at the meeting of the British Association at Edinburgh in August last, I had, by the kindness of my pupil Mr John E. Garner, then at Fraserburgh, the opportunity of dissecting a Hyperoodon which stranded in Fraserburgh Bay. Although it is supposed that no muscles passing from the forearm to the hand exist in any of the Delphinoid Cetacea, I may mention here that they were well developed in this Bottlenose. It was a male, 20 feet in length. The flexors were arranged much as above described in the Razorback, but relatively to the limb they were larger, especially the Flexor communis. The Flexor carpi ulnaris passed between a long, curved, and flexible olecranon cartilage and a movable pisiform cartilage. On the dorsal aspect there were two common extensors; the radial, largest (the extensor communis of man), sent tendons to digits II, III, and IV; the ulnar extensor (the extensor minimi digiti of man, the external common extensor of the quadruped) sent tendons to digits IV and V. Slight insertions into the carpus as they passed seemed to indicate that at least the extensor carpi ulnaris was also included. Digit I, the pollex, received no tendon, the extensor slip and flexor bundle as if going to the pollex, stop on the first joint of the index and partly reach the terminal ligament of the pollex. The digital joints reach completely across the cartilage and allow of greater movement than in the Razorback, in accordance with the greater development of the muscles. The forearm and finger muscles will probably be found to exist in most if not in all Whalebone Whales, and in others among the Delphinoid Cetacea besides Hyperoodon. Of Narwhal I have a dissection showing their presence morphologically, but histologically they are throughout represented by fibrous tissue, and functionally they are ligaments. I inferred that the Flexor carpi ulnaris would be the likeliest to be present, and on looking for it in the paddle of the common Porpoise I find it is present there; the short fusiform belly attached to an immovable olecranon, the tendon attached to a movable pisiform cartilage, and previously connected along its distal third to the edge of the ulna.

(b) *Separate Capitular process of First Rib.* The following observation may perhaps help to account for the different appearances presented by the head of the first rib in Whales. Articulated to the end of the first rib, as seen in Fig. 4, there is a separate beak-like bone or process, with intervening layer of cartilage. This cartilage is now broken across, but the connecting ligaments still remain in the preparation. It fits accurately against the surface of the rib from which it has been detached. Length 4½ inches, tapers to a blunt end, inner border convex, outer border concave, front surface convex, hinder surface flat. At base, breadth 1¾ in., thickness 1; at middle, breadth 1¼, thickness ½ inch. Unfortunately the connection of the first ribs to the vertebræ was severed in my absence and under circumstances which must leave it in doubt whether this process was present on the right side also. The ankylosis of such a process would give the rib a well-marked capitular beak, while its loss, in forcible disarticulation or in maceration, would leave the rib with the form usually represented. The upper part of the *second rib* is represented in Fig. 5, showing its well-marked capitular process, 10 inches long. Length of entire rib, along outer edge 93 inches, straight to angle 68, straight to head 61, depth of curve 19. Breadth, below angle 4¾, average of shaft 5½. *First rib.* Length, straight 51½, along outer border 64; depth of curve 11½; breadth between tubercle and angle 5½ to 6, below tubercle 4¾, half-way to sternum 5½, close to sternum 6, at lower end 11, including the cartilage 12.

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[1] See various mention of the Ribs in Whales by Prof. Flower, *Notes on the Skeletons of Whales in the principal Museums of Holland and Belgium*, *P. Z. S.* 1864; and in *P. Z. S.* 1865, p. 472, and p. 699; 1869, p. 604; 1870, p. 330.

[2] Since the above was written, I have noticed in a common Porpoise, a male, 5 feet long, the 13th pair of ribs suspended in exactly the same position as the 16th in this Razorback, the short 8 inch rib suspended behind the inferior part of the 8 inch vertebral 12th rib. A ligament passed up from it for 3 inches towards the spine, where it had been divided in separating the ribs.

THE STERNUM.—This sternum is interesting as showing variation, and as bearing on the question of the differences between that bone in *B. musculus* and in *B. Sibbaldii.* The form is shown in Fig. 4, sketched from the preparation, 4 feet 3 inches in each direction, after it was carefully cleaned, the natural connection between the sternum and ribs being left. The sternum and first rib articulate at two places, externally (lateral costo-sternal articulation), for 5 inches, below the outer part of the wing, and internally (terminal costo-sternal articulation) in the recess between the wing and posterior process. These articulations are effected by fibrous tissue, and there is a cartilage at one side of each, on the sternal side of the lateral, and on the costal side of the terminal joint. These may be regarded as cartilages of growth, but they also give elasticity at the joint and attach the ligament. Only the interosseous part of the ligament is shown in the sketch, the more superficial and stronger part of the great connecting ligament having been dissected off to show the exact relation and form of the bones and the cartilage. The motion was free at both joints, the interosseous part of the ligament being about half an inch in length, but the two joints assist each other and give a very strong union. Between the two joints is a space 6 inches in breadth. The sternal end of the first rib expands greatly and presents two separate cartilaginous tips, between which the middle third of the end of the rib is thin, concave and non-cartilaginous; one on the anterior angle or process, 3½ to 4 inches broad, belongs to the terminal joint, the other at the posterior angle is free. The deep recess between the ends of the first ribs is 9 inches broad at the middle, 8½ at the hinder end. It is 8½ to 9 inches in depth at the sides, to the sternal joint, subdivided by the xiphoid process which projects free into it, and stops short 4 inches from the mouth of the notch.

It is in the length of the posterior process and in the greater or less filling up of the antero-lateral notches that these sterna vary. Viewed in its connections, the interpretation of the essential parts of the sternum is evident. The thickest part reaches across as a beam opposite the costal joints, supporting the first ribs and completing the visceral arch. The hinder part of this beam is at the root of the posterior process and between the two terminal joints; the anterior part of it is between the lateral joints, and forms the posterior portion of the wings. In front of this the bone begins to shelve off rapidly to a thin cervical edge, the anterior development of the median process and the wings and the greater or less filling up of the antero-lateral notches, depending on muscularity, age, and individual variation. At the deepest part of the postero-lateral notch, at the meeting of the posterior pedicle with the wing, there is a special articular notch, most marked on the pedicle, for the terminal joint of the rib, and so far the pedicle is essential and exists in all the varieties. The pedicle may stop here or project variously beyond it in different species and in different individuals, depending on muscularity, age, and variability.

The sternum in the Razorback is known to vary in its form and dimensions[1]; but in this Razorback it departs so much from the form assigned to it as distinctive from that of Sibbaldius as to have on the whole a greater resemblance to the latter, more so anteriorly, less so posteriorly at the xiphoid process, which is intermediate. This will be seen if Fig. 4 be compared with the figures given of the sternum of the Razorback and of Sibbaldius by Prof. Flower[1] and by Prof. Turner[2] of his Longniddry Sibbaldius, the latter being from a very large and nearly adult specimen, the length and breadth of the sternum in it and in this Razorback being exactly the same.

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[1] Lilljeborg, *Synopsis of the Cetaceous Mammalia of Scandinavia*, 1861-2, Ray Society's translation; and see dimensions of specimens given by various authors.

The following are the measurements of the sternum, in inches. Breadth, straight, 26½, add over an inch at each end for cartilage; length 17½; length of anterior median process, from level of notches, 4; depth of antero-lateral notches 2⅛; length of wing at narrowest part 5½, at broadest 6½; posterior process, length 7½, from level of wings 8½, breadth where first ribs meet it 4⅝, two inches from apex 2; depth of postero-lateral notches, right 4¾, left 4¼. Thickness at mesial line on level with back part of wing 2½; back part of wing at middle 1⅜, wing in front of this rapidly shelving; base of median cervical process 1⅜; posterior process, at base 2½, at middle 2⅛, before bevelling of point 1⅜. Foramen, from end of anterior process 7½, passes through the bone very obliquely forwards and upwards, admits goose-quill. Depth of concavity along median profile of bone 1⅜, but processes a little convex, especially posterior; transverse convexity of bone gives upward retirement of 5 inches opposite outer end of wing. On visceral surface, depth of hollow from transverse concavity 3½; division of bone, longitudinally, into three parts well marked, middle thick and flat, anterior third shelving forwards and concave both ways, posterior third, on pedicle, a little concave both ways. The general view of the pectoral surface suggests a saddle. The prominent longitudinal ridge is 1½ inch to right side of middle line, and anterior process is correspondingly twisted. Whole of anterior edge of wing thin, sharpest at the hollow, becoming rough at the convex part. Hinder edge sinuous and rough at gap between the joints. Posterior process prismatic, lower edge of notch for terminal costal joint well marked, process tapers behind this, at first rapidly then gradually; last 1½ inch rapidly bevelled to blunt point, rough, and was coated with cartilage.

[1] *P. Z. S.* 1864, p. 393.

[2] In this *Journal*, May 1870, p. 273.

CERVICAL VERTEBRÆ.—Among the osteological characters of the Razorback have been given—"Neural arches of the cervical vertebrae low; spinous processes very slightly developed"—and among those of Sibbaldius "Neural arches of the cervical vertebræ high, and their spines well developed[1]." I notice this point as I have the neck of another great Fin-whale, a larger and older male, ashore near Wick in 1869, and the comparison of the two shows marked difference in the above character. In the Peterhead specimen the arches are comparatively high, giving a triangular form to the canal, with well-marked though not long spines. In the Wick specimen the arches are so low and broad as to give the canal rather a semilunar form, the spines are wanting, or are mere roughnesses, on the three middle vertebræ and very short on the 6th and 7th; the processes which project backwards from the laminæ, internal to the posterior articular processes, are much better marked than the rudimental spines; and the laminæ are, anteriorly, as thin as writing paper, in some parts cribriform and flexible, while in the Peterhead specimen the laminæ are strong. The height of the canal in the latter is partly owing to the upper wall of the bodies being as yet concave transversely, while in the Wick specimen they have become convex, but the lowness of the arch in the latter is mainly owing to the pedicles being placed farther out on the bodies and to the laminæ being low. The thinness of the laminæ would seem to indicate that disappearance by absorption has been going on. Nor does the supposed distinction in the transverse processes of the atlas, and in the spine of the axis, seem to be reliable, the differences not being greater than muscularity, size of animal, and age would account for. This will be the more readily understood when we call to mind the considerable variation presented by the spine of the axis and the transverse process of the atlas in man.

The rings of the transverse processes are complete from the second to the fifth, but the terminal expansions external to the apertures are as yet very little developed in the 3rd and 4th. The 6th presents the not unfrequent bony deficiency in the inferior transverse process. It occurs here on both sides, at the grooved part, for about 1½ inch. The gap was filled naturally by cartilaginous tips and thick intervening ligament. This gap exists only on the right side in the older Wick specimen. The 7th vertebra, as usual, has no inferior transverse process.

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[1] Flower, *P. Z. S.* 1864, p. 392.

CHARACTERS AND MEASUREMENTS OF VARIOUS PARTS.—The following notes of characters and measurements will show the species to which this Whale belonged, and may be of interest to the anatomist for comparison with the characters in other specimens. All the numbers refer to inches unless feet are mentioned.

(a) *Colour.* Putrefaction having already commenced, the colour could not be much relied on. It was black on the back, and patches of adhering dark cuticle here and there on the sides and in the furrows showed that the dark colour had extended well down the sides. No traces of dark colour were seen on the mesial ridges or furrows, as if the colour had been naturally white there. Unless the carcase is fresh and moist, statements in regard to the colour of Whales must be received with caution. The blubber was about 2 inches thick.

(b) *Tail Fin.* Tip to tip 14 feet. Greatest antero-posterior measurement of each side 3 feet 8 in. The surfaces and edges were so worn and macerated as to present a fibrous appearance, so that the tail might readily have been described by a person unacquainted with structure, as covered with white hair. With regard to the view that one fluke is naturally bent up and the other bent down, on the principle of a screw-propeller, I am led to put the question, for future observers, whether this difference on the two sides is not the accidental result of position. Here the right fluke was concave up, the left convex up, and this was evidently owing to the body lying on the right side. The carcase usually lies more or less on one side, the natural effect of which on a transverse tail is to render that fluke concave up, the other convex up, and lying some time in this position will perpetuate it in drying. Mistakes are apt to be made in reporting as to right and left.

(c) *Dorsal Fin.* Well marked. Falcate. Height vertically 15, length at base 24 to 26. Distance from end (median notch) of tail 15 feet 8 in. Distance (of middle) behind anus 28. Near the base of its concave posterior margin there was a deep semilunar notch, two inches in diameter. Though now perfectly regular and smooth-edged, it may have been the result of a bite or shot. The remains of a rocket, which the whale-fishers believed to have been the cause of death, was found in the right pelvic region.

(d) *Caudal region of Trunk.* From anus to end of tail 18 feet, to anterior edge of tail, being caudal part of trunk, 15 feet. Presents strongly the "razor-back" character, suggesting almost a double-edged knife. This much more strongly marked along the posterior than on the anterior half. Dorsal ridge farther from lateral line than ventral ridge and more convex. Semi-girths of this region, at anus 6 feet 4 in.; ¼ way back, 5 feet 5 in.; half way, 5 feet; ¾ way back, 4 feet 4 in.; half way between last and tail, 3 feet 9 in.; just in front of tail, 2 feet 10 in. Median ridge runs half way back on tail fin.

(e) These semi-girths may be relied on; those taken over abdomen or thorax are liable to be affected by distention. Approximative semi-girth opposite hinder end of pectoral fin was 13 feet. Semi-girth two feet behind eye, 13 feet 10 in., just behind eye, 13 feet 7 in. The *plaitings* were mostly fully opened out, the furrows being now as broad as the ridges. They commenced at side of lower jaw 4 feet in front of eye; extended back 32½ feet on the side, 2 feet farther on the belly, reaching on the belly to 6 feet from penis, which was protruded at 4 feet in front of anus.

(f) *Head. Eye.* Distance from beak of upper jaw to anterior canthus, along the lip 13 feet, straight 12 feet 9 in. Canthus to canthus 4½. *Ear-hole*—Behind posterior canthus 30 inches, in front of where upper edge of paddle leaves trunk 66. Admits with difficulty point of little finger, cuticle now off; 4 to 5 inches in, not larger than crow-quill[1]. Projection of lower jaw beyond upper about 2 feet, but exact distance uncertain as lower jaw was thrown to one side. From beak of upper jaw, along whalebone, to deep part of angle of mouth 12 feet 4 in. Superficial part of angle is 9 inches farther back. *Whalebone.*—On outer view black, hairy tips showed a white fringe; whole of inner, or buccal, surface, a white hairy matting, not cream-coloured as in Pike Whale, but quite white. Length of longest plates on outer side, measured straight, 22 inches, at symphysis 6. The two sides continuous at symphysis. Breadth of the grooved surface of the whalebone matrix, after the plates were removed, measured straight, the surface being concave across as well as longitudinally—at 6 inches from front, 2 inches; one foot back, 5; two feet back, 8; three feet, 10½; four feet, 12; from six to eight feet back, 13; ten feet back, 12; ten and a half feet back, 11; twelve feet back, 9. Breadth of rim of jaw outside whalebone, at side 6 inches, at symphysis the same. *Palate.*—Like a raised beam, narrow and smooth, convex transversely for 17 inches back; then a median groove broadening backwards to six feet back, behind which palate projects more and more to a rounded margin. Breadth of free rounded surface, at front 6 in.; after six feet back, narrows to 5, then to 4. Total length, from 6 in. behind beak, 12 ft. 4 in. Height to which palate projects above level of whalebone matrix—at three feet back, 3 in.; at five feet, 6; at seven feet, 9; at nine feet, 13 to 14; at ten feet, 15; at eleven feet, 14; at twelve feet, 6. Total length of *skull*, from beak of upper jaw, 15½ feet. Greatest breadth of skull, just behind temporo-mandibular cushion, 6 ft. 3 in. The following breadths of the beak had to be taken from below, across roof of mouth, and therefore in a double inclined plane. The rise of the palate backwards will be kept in mind as one cause of the increase in the measurements backwards. At one foot back, 17 inches; at two feet, 23; at three feet, 28; at four feet, 34; at five feet, 38; at six feet, 42; at seven feet, 43; at eight feet, 45; at nine feet, 48; at ten feet, 50.

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[1] The cuticle being off I could not ascertain whether there was present the fine white streak which I observed in a 14½ feet long Pike Whale, running forwards from over the shoulder to the ear-hole, which was very small and grooved posteriorly, so that in swimming forwards the water will not enter.

Temporo-mandibular cushion. A fibro-adipose mass, now measures, in length 30 inches, in breadth 24, in height 15 to 18; lower jaw having been separated, the mass may have been larger. Front half light yellow colour, more fatty, cuts like firm blubber; hinder half white and yellow colours mixed, more dense, the fibrous element predominating; transition from front to back gradual. *Lower Jaw.*—Length, straight 14 ft. 4 in.; along curve on outer side 15½ feet. Depth of curve at middle, where greatest, 2 feet. Body, height near symphysis 9 in., at middle 12; greatest thickness 7. Lower border sharp all along; upper border, or surface, 6 to 7 inches broad, its inner edge rising up sharp along the three feet next coronoid process. Height of bone to tip of coronoid 21, at one foot in front of coronoid 15. Height of coronoid process proper, behind, from level of front of sigmoid notch, 9; in front, from level of body, 4½; intermediate, 7. Across its oblique base, 9; across middle, 6. Thickness about 2½. Highest part of upper edge is in front, from which it slopes down and back. Upper half bent outwards. Jaw between condyle and coronoid concave externally, convex internally. Length of sigmoid notch to tip of coronoid 30, to back of coronoid 24; greatest depth of notch 8. Dental foramen, from condyle 17, from coronoid 11. Contents: mouths of at least 24 vessels seen; one artery ½ inch in diameter, two less, and other four or five larger than goose-quill; the others, size of small goose-quill. Veins, the thin-coated vessels, much smaller than the arteries. A large nerve, as thick as thumb, funiculi in a sheath, placed above vessels. Temporo-mandibular cushion adhers to condyle. Uniting tissue at symphysis, about 2 inches thick between, thicker in front superficially.

(g) *Pectoral Limb.* Distance from beak of upper jaw to shoulder 19 feet, to axilla 21½ feet. The form is represented in the sketches Figs. 1 and 2. The small size of the paddle was evident on the first view of the carcase and characteristic; length along lower border 8 feet, along upper border 5½ feet. Exact length after removal, from head of humerus, 7 feet 8 in.; greatest breadth, at the pisiform cartilage, 19 in. On dissection the bones and joints presented the following measurements, in inches. *Scapula,* height 28; breadth 51, increased by posterior cartilage to 62; a strip along base connects the two cartilages; anterior cartilage adds 4 to height near anterior part of base. Coracoid, length 5½, increased by cartilage to 8, breadth 3½. Acromion, length 10, increased by cartilage to 11½, breadth, 4½. Glenoid ligament much deeper at hinder end of cavity, and capsular ligament continuous with it. *Humerus.* Both epiphyses ankylosed, length 21, including cartilage, which is $\frac{3}{16}$ thick on the head. Same over all the bones at elbow, but thicker at the edges and ridges. Length of Radius 33; of Ulna, from elbow, 30½, from end of bony olecranon 37½. *Olecranon cartilage*, projection along middle 10, antero-posteriorly 10½; thickness near bone 1¾, at middle 1, shelving to edges, distal half flexible towards surfaces but not longitudinally. Especially the thicker parts marked with numerous pits.

Carpus. At middle the soft mass is 7 to 8 in length. Included in this are (a) Epiphysial cartilages of radius and ulna 1 to 1½, about half of these conceal the bony epiphyses at depth of ¼ inch, half projects beyond. (b) Epiphysial cartilages of metacarpals, those of the middle digits ⅝. (c) The carpus proper, five cartilages (beside pisiform) with their central ossifications, 3 in first row, 2 in second. On palmar aspect the 3 bones of first row nearly of same size, those of second row considerably smaller. On dorsum, first row nearly as on palmar, scaphoid less, cuneiform more; in second row magnum more, unciform much less. The true anatomy of the carpus is seen on examining the cartilages of which these "bones" are the more or less ossified centres, leaving, in this specimen, variously half an inch or more around of cartilage unossified. When the perichondrium is removed the outlines of the cartilages are recognised, united along their adapted articular surfaces by narrow tracts of ligament. *First row* 4 as in man. Scaphoid and semilunar articulate with radius, cuneiform with ulna. Pisiform articulates distally with cuneiform, at middle with ulnar epiphysis, and for an inch by loose ligament with bony ulna; length 5, free edge 3½, breadth 3; thickness near articulated edge ⅞, at middle ⅜, shelving to edges; flexible on surfaces; motion at articulated edge, but very little in direction of flexor carpi ulnaris. *Second row*, must be regarded as homologous with the magnum and unciform. Magnum serial with digit III, articulates also with part of II and part of IV, as in man. Unciform, serial with IV and articulates also with part of V. Two-thirds of V rest on cuneiform, and half of II on Scaphoid[1]. The lines of articulation of the carpal cartilages are shown in Figs. 1 and 2 as far as the tendons and the great reduction permit. The similarity of the articulations of these cartilages to those of the corresponding bones in man, and other mammals, is evident.

Digital Bones. Number in each of the four digits, including metacarpal, II and V, 4 each; III 7, IV 6. As the lengths of the metacarpals and phalanges are given as distinctive between B. Musculus and Sibbaldius, I subjoin the length of each, in inches, taken at the middle, in their order. II 5, 5⅜, 5, 3¼, terminal cartilage 1½; III 6¼, 6¼, 5, 3½, 2¼, 1½, ⅜, terminal cartilage 1; IV 5½, 5¼, 4¾, 3⅝, 2½, 1, terminal cartilage 1; V 4⅛, 4⅝, 3⅞, 1½, terminal cartilage 1. Total length of each finger before the cartilages had shrunk—II 24¾; III 33½; IV 31; V 19. The cartilages also were measured, but it may suffice to mention generally, that the proportion of cartilage (including the terminal cartilages) to bone in the fingers is about one to three, cartilage forming about one-fourth of the whole digit. The swollen "joint" between the successive phalanges is a mass of cartilage adherent to the bones, and continuous from bone to bone except partly across the middle, where, for the middle third or less, there is a narrow joint, seen on both aspects, covered in by membrane. This joint disappears at the smaller interphalangeal cartilages. The mode in which the nodes and hollows of the two radial digits are adapted by alternation is shown in the sketches.

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[1] In the Wick specimen there is a small separate bone in the situation of the trapezoid, serial with II, not showing on the surface. Also, the magnum and unciform have united, on the two surfaces but not deeply, into one bone.

I regret that circumstances prevented a more complete examination of the anatomy of this Whale from being made. The difficulties attending the dissection of so large a carcase, the more so when it is already putrid, are well known to those who have tried. The weather while I was working on the beach was not favourable, and most of the remaining work had to be done in the month of July, when I was occupied with the duties of the summer session. I must not omit to mention that in making out these dissections I derived valuable help from my experienced and accomplished Assistant, Dr James Rodger.

ON THE RELATION OF THE TEMPERATURE OF THE AIR TO THAT OF THE BODY. By A. H. GARROD, *St John's College, Cambridge.*

THE nature of the evidence affecting theories in biological science is generally so far from direct, that it is only by the systematic working out of many of the necessary deductions that any idea can be formed as to their value. The experiments detailed in this communication were suggested by the theory to be referred to immediately, and their close agreement with its requirements tends strongly to substantiate its accuracy.

In a paper published elsewhere[1] I have detailed several observations which tend to shew that many of the minor fluctuations in the temperature of the human body result from alterations in the amount of blood exposed at its surface to the influence of external absorbing and conducting media. Others have repeated these experiments[2], and obtained the same results.

For example; on stripping the healthy body in an air of about 50° F., a rise of the internal temperature (judged by that of the floor of the mouth) commences immediately, and in about half an hour amounts to as much as three-fourths of a degree. According to the above-mentioned theory this phenomenon is explained thus; the contact of the cold air against the surface of the skin, previously maintained at a much higher temperature by the clothes covering it, produces so considerable a contraction of the cutaneous muscular vessels, and the blood is driven so far inwards, that the conducting power of the thus modified skin is rendered considerably less than that of the clothes and blood-filled skin combined, in the previous condition; consequently the body temperature rises until a higher equilibrium is attained.

Such being the case, and the contraction of the cutaneous vessels being evidently caused by the cold, it is more than probable that the amount of this contraction should depend on the degree of cold applied, that is, on the temperature of the external air in which the observation is being conducted;

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[1] *Proc. R. S.* No. 112, 1869, p. 419, et seq.

[2] J. F. Goodhart, *Guy's Hospital Reports*, 1869.

and the extent of this action would manifest itself by its effect on the body temperature, less cutaneous contraction causing less diminished conduction and consequently less rise of temperature on stripping.

Similar reasoning would lead us to anticipate a temperature of air sufficiently high to produce exactly as much cutaneous contraction as will make up for the loss of the clothing, and consequently no change in the body temperature on stripping.

The correctness of these deductions may be judged from the following observations, which were all made under similar conditions, on myself, while standing.

I.

Time.	Temperat.	Temp. Air.
11.15	98.95	47° F.
11.20		
11.25	98.975	
11.30	98.975	
11.35		
11.40	99.3	
11.45	99.35	
11.50	99.575	
11.55	99.625	
12 NIGHT	99.7	
12.5	99.675	

Stripped at 11.30. Rise 0°.7 F.

II.

Time.	Temperat.	Temp. Air.
11.15	98.8	52° F.
11.20		
11.25	98.8	
11.30	98.8	
11.35		
11.40	99.	
11.45		
11.50	99.35	
11.55		
12 NIGHT	99.375	

Stripped at 11.30. Rise 0°.575 F.

III.

Time.	Temperat.	Temp. Air.
10.45	98.1	59° F.
10.50	98.	
10.55	97.925	
11 P.M.	98.	
11.5	98.19	
11.10	98.35	
11.15	98.4	
11.20	98.425	

Stripped at 10.55. Rise 0°.5 F.

IV.

Time.	Temperat.	Temp. Air.
11 P.M.		67° F.
11.5	99.	
11.10	99.	
11.15	99.	
11.20	99.	
11.25	99.05	
11.30	99.19	
11.35	99.21	
11.40	99.19	

Stripped at 11.15. Rise 0°.2 F.

V.

Time.	Temperat.	Temp. Air.
10.15	99.15	71° F.
10.20	99.15	
10.25	99.15	
10.30	99.125	
10.35	99.025	
10.40	99.125	
10.45	99.175	
10.50	99.175	
10.55	99.175	
11 P.M.	99.175	

Stripped at 10.30. Rise 0°.05 F.

VI.

Time.	Temperat.	Temp. Air.
10.15	98.8	71° F.
10.20	98.875	
10.25	98.95	
10.30	98.95	
10.35	99.	
10.40	99.	
10.45	99.	

Stripped at 10.25. Rise 0°.05 F.

VII.

Time.	Temperat.	Temp. Air.
10.30	99.21	72° F.
10.35	99.205	
10.40	99.2	
10.45	99.3	
10.50	99.3	
10.55	99.15	
11 P.M.	99.35	
11.5	99.3	
11.10	99.325	
11.15	99.4	
11.20	99.425	

Stripped at 10.50. Rise 0°.125 F.

VIII.

Time.	Temperat.	Temp. Air.
10.15	98.8	73° F.
10.20	98.825	
10.25		
10.30	98.9	
10.35	99.	
10.40		
10.45	99.1	
10.50	99.1	
10.55	99.1	
11 P.M.	99.1	

Stripped at 10.36. Rise 0°.1 F.

It is readily seen that the hotter the air, the less is the stripping rise, and that when an external temperature of 70° F. is reached, there is no rise at all. Several of the higher temperature observations are here given and but few of the lower, because in the paper above referred to (*Proc. R. S.* No. 116, 1869) there are six or seven of the latter recorded with the temperature noted in all.

From these facts it may be clearly seen that *in air below the temperature of* 70° F., *the stripping rise varies inversely as* *the temperature.* Experiments as low as to 45° F. have been made, but no limit has been reached in that direction yet. Above 70° F. of the air, the results are modified by the sweating that *always* accompanies so high a temperature if the body is clothed, and quite a different class of phenomena appear, which have not been much studied.

In V. and VII. there was a slight fall of temperature at the moment of stripping, this was probably connected with the perceptible moisture on the surface which evaporates almost immediately the clothes are removed.

With regard to the nature of the clothing removed. It always had considerable non-conducting power, being composed in all cases of at least two layers of woollen material; though, as the observations in the warmer air were made in summer, and those in the colder, during corresponding seasons; the dress worn varied with the time of year, being thinner in the former and thicker in the latter. On the whole the amount of clothing worn does not seem to affect the results as long as there is sufficient to keep the body warm under ordinary circumstances; and in the English climate to do this, one woollen covering seems always essential.

Some results obtained by Dr V. Weyrich[1] with regard to the hygrometric condition of the skin at different temperatures of the atmosphere, obtained by means of an hygrometer specially adapted for the purpose, bear so fully on the subject under consideration that they will be here given.

1st, When the body is clothed, the amount of moisture excreted by the skin, does not vary appreciably when the observations are conducted in an air below 70° F.

2nd, When above 70° F. the amount of moisture excreted by the skin rapidly increases with a rise in the temperature of the atmosphere.

It is thus seen that by means of an entirely different method of observation, Weyrich finds that in an air of 70° F. sweating commences; and by a combination of his results with those arrived at from the facts given above, the following conclusions may be drawn :—

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[1] *Die Unmerkliche Wasserverdunstung der Menschlichen Haut.* Leipzig, 1862. Abstract in *Brit. and For. Med. Ch. Rev.* Oct. 1863.

With regard to the human body, when covered with badly conducting clothing, 70° F. is a *critical* temperature of the atmosphere. The removal of the clothing at that temperature produces sufficient contraction of the cutaneous muscular arteries to counteract the cooling effects of its loss, and consequently the internal temperature does not change; whilst on stripping at lower temperatures, the vascular contraction induced, more than makes up for the covering lost, and is consequently followed by a rise of internal body temperature; which, like the vascular contraction, is greater as the cold is more considerable. Above 70° F. the amount of perspiration varies with the degree of heat and so far compensates, by evaporation, for the differences of temperature as to maintain the body at a nearly uniform temperature.

The temperature of air at which sweating begins in the nude body is not known. It is at about 86° F. when standing at rest.

ON THE MALAYAN TAPIR, *Rhinochoerus sumatranus* (Gray). BY JAMES MURIE, M.D., F.L.S., F.G.S., &c.; *Lecturer on Comparative Anatomy, Middlesex Hospital: formerly Pathologist to the Glasg. Roy. Infirmary: Assist. Conservator Roy. Coll. of Surg. Eng.: and late Prosector to the Zool. Soc. Lond.* (Plate VIII.)

1. *Preliminary Note and the Outward Features.*

THE subject of the present anatomical sketch was a nearly adult female animal, which died some eighty hours after its arrival in England. The stuffed skin and the prepared skeleton are now set up among the series of Natural History in the Liverpool Museum. The specimen accorded with what goes by the name of the Indian, Malay or Sumatran Tapir, often spoken of as the Asiatic, in contradistinction to the American species. Specific distinction is based on its being maneless, its hairy coat being thin and very short, and the head, neck, fore and hind quarters glossy black, with a great bodily girdle of white[1], which com-

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[1] With such a large mammal as the Tapir it is not a little remarkable that only within the last few years has a new kind been added to science in the discovery in Panama of a sort combining characters of those already known of the Old and New World, but moreover possessing some striking peculiarities of its own.

I may call attention to a lithograph by Mr Wolf (*P. Z. S.* 1867, Pl. XLII.) of the young and adult of this creature, Baird's Tapir; the Malay animal has been often figured (*Trans. Linn. Soc.* Vol. XIII. &c.), and on account of its hues Wagner termed it *T. bicolor*.

The literature concerning the Tapiridae is ample, especially that devoted to the skeleton. Pander and Dalton (*Vergleich. Osteol.*), De Blainville (*Osteographie*), others, Wiedemann, (*Archiv. Zool.*), and Sir E. Home, (*Phil. Trans.*) &c. have given many delineations of the bones and descriptions thereof, but by far the most lucid account of their osteology is that of Cuvier in his *Ossemens Fossiles* (Tom. II. pt. 1, chap. IX. and accompanying Plates). This acute observer, in giving a résumé of comparison between Indian and American Tapirs, was struck by their differences, which however he only considered worthy of specific distinction, retaining the genus *Tapir* for both. In a comparatively recent communication on the living Tapirine family, Dr J. E. Gray (Notice of a new species of American Tapir (*T. laurillardi*) &c., *P. Z. S.* 1867, p. 876, where a copious reference to authorities is given), after a careful study of their crania divides the group Tapiridæ into three genera—*Tapirus*, *Rhinochærus*, and *Elasmognathus*. To the first he allots three species, to the second two, and one to the last, in all six species. Whether these divisions will remain good among naturalists the future will show. For my own part I adopt the generic term *Rhinochærus* as expressive of the cranial difference, which is as trenchantly marked from *Tapirus*, as the former is from the very characteristic *Elasmognathus Bairdii* (Gill, see Verrill in Silliman's Amer. *Journ. Science*, July 1867, and above-mentioned paper). A living specimen of this animal has for the first menced about four inches behind the scapula and extended backwards to within a couple of inches of the tail. The white colour did not quite meet in the median abdominal line, a longitudinal darker band some four inches wide here separating the right from the left side; on the hip also the white reached only a very little below the great trochanter. The tail is almost as broad at the root as the free-part is long; this gives it a nearly equal-sided triangular form. Its total length from the hinder edge of the grey colour to the tip is 5·5 inches, but the free portion or tail proper is but 3·5 inches in length. The position is peculiar, it seeming to be placed much lower than the sacral region, which gives a very dumpy or truncate character to the buttocks. Of the four toe-nails or hoofs belonging to the front foot, (vide Fig. 6, pl. 9), the outermost is the smallest, and the third hoof is next in size. The innermost or first corre-

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time been brought to this country alive, and lately was exhibited in the Regents Park Gardens (see notice and fig. *Field*, 7 Oct. 1871). One has a difficulty in selecting a specific name for our present eastern form, *T. indicus*, *T. sumatranus*, *T. malayanus*, and *T. bicolor* having been respectively used by various authorities.

According to the law of priority the first mentioned synonyme possibly ought to stand, but Gray's *T. sumatranus* denotes well the limitation of its habitat (for a Chinese variety is said to exist), and prevents confusion as to coloration, now that the parti-coloured Panama tapir is known.

It behoves me, in no unkindly way, to take note of a slip of my good and true friend Dr Gray. In his paper referred to above he says: "Cuvier states that the Malay Tapir was discovered in India by M. Duvaucel," and corrects him thereupon. It is true this expression is made use of by Cuvier (*Oss. Foss.* Art. II. p. 156), but these words must be understood in a very modified sense, for previously in p. 143 he distinctly mentions that his pupils MM. Diard and Duvaucel saw the animal in question at Barkpoor near Calcutta, it having been transported to the Governor-general the Marquis of Hastings from Sumatra. Cuvier's pupils afterwards obtained the animal in the woods of Sumatra, they dissected specimens and transmitted the skeleton and skin of a female to the Museum d'Histoire Naturelle at Paris. I believe the real interpretation to be that Duvaucel died, and his MS. transmitted home, confusion arose regarding Major Farquhar's tapir, described *Asiat. Soc.* 1816 (Gen. Hardwick's Coll.), and what the Frenchmen afterwards saw in Sumatra.

While thus virtually supporting Dr Gray's separation of the modern Tapirs, as most useful in some ways, being based on structural variations quite as notable as in admitted ruminant genera, I confess doing so with a certain amount of hesitation; forasmuch as when the numerous fossil forms of tapirs are studied in comparison with the recent ones, it almost behoves us to make every individual a genus by itself. In fine, were the fossil remnants of tapir sufficiently intact and brought together side by side with the skeletons in our museums, I believe a very graduated series, such as to baffle detection of the changes from one to the other, would result. Nay more, the same might almost be said in allusion to the ancient *Paleotherium*, *Paloplotherium*, *Lophiodon*, *Coryphodon*, etc. which lead by the easiest steps possible from the tapirs themselves to groups usually denoted remote. Perfection in classification is the naturalist's Will-o'the-Wisp. I am content to use such as is appropriate notwithstanding its deficiencies, which some cavil at but do not improve.

sponds very nearly with the third, while the second hoof is considerably the longest and largest of the four. The second hoof is broad and shovel-shaped, the anterior free border being rounded; the remaining three hoofs are narrower and more pointed. The pad (*p*) or fatty cushion on the sole of the foot is heart-shaped. The middle hoof of the three-toed hind limb projects far beyond the outer and inner (Fig. 14). Like the second of the fore foot this, or middle digital hoof, is broad and shovel-shaped. The inner and the outer hoofs, equivalent to the second and fourth nail-digits, are nearly equal in length, but are not quite half the length of the middle hoof, They agree with the outer hoofs of the fore foot in being narrowed and sharp at the tips. The sole of the hind is narrower than that of the fore foot.

The following measurements of the body were taken by me :—

Total length—following the curve of the back	87	inches.
Height at the shoulder	39	...
... haunch	40	...
Girth round chest (at the anterior margin of the white colour)	54	...
... middle of the belly	60	...
Head—from the tip of the snout to the occiput	23	...
... depth in a vertical line opposite post-angle mandible	11·5	...

The small elliptical eye is 1·25 inch in its longest diameter. Its exact relative position is four inches from the summit of the head and six and a half inches from the base of the lower jaw. Between the posterior angle of the mouth and the anterior (or inner) angle of the eye there is a space of four inches; and between the posterior angle of the eye and the middle of the ear, seven inches.

Around the angle of the mouth there is a thin edging of longish white hairs with a few intermixed but somewhat scatterred long black ones. At the tip of the under surface of the proboscis below the nostrils are a few diffused bristle-like hairs, easily pulled out, so loosely are their roots attached to the skin. Over the proboscis, and in fact distributed here and there over the greater part of the front of the head, are longer separate black hairs. The hair on the dorsal region of all the feet does not quite reach the hoofs, but stops short about a quarter of an inch from them, being defined by a sharp line of demarcation. In this respect the dorsal hairy covering resembles the plantar one in terminating abruptly. An injury had befallen the ears, so that both were imperfect. The left, which remained in the best condition, measured 5 inches long and 3 broad when in the natural condition, but when opened it was 4½ inches across. The mammary glands were small, the animal having barely reached puberty; and just previously having undergone the privations of a long voyage may have conduced or prevented their natural enlargement. Two broad, flat and but slightly projecting teats were situated in the inguinal region. Each of these had from 6 to 8 perforations, which were observed beneath or when the skin was removed, but externally or superficially no openings were apparent. The labia bordering the vulva are well pronounced, and there is an indistinct raphe or shallow sulcus running between the vulva and the anus. The distance between the middle of the vulva and the centre of the anus is 3·2 inches. Length of the vulva 1 inch.

Although the hide of the Sumatran Tapir is soft and flexible compared with that of the Elephant and Rhinoceros, it still retains much of the pachydermatous character. In the present instance when being fresh flayed it felt remarkably stiff and unyielding to the knuckles, causing the operation to be a most laborious and fatiguing one to the wrist. Owen's[1] account of the Indian Rhinoceros recurred to my mind, inasmuch as the Tapir's hide is very much thicker at the neck and shoulders, and is even denser and thicker over the iliac region and haunch. The fibres of the panniculus carnosus muscle are, as it were, interblended with the fibrous sub-cellular dermal tissue, so that the hide at this part is very closely adherent and difficult to be removed; over other parts of the body and limbs, however, while tough it was more yielding.

I had the curiosity to weigh the skin and found it to be 62 lbs., a weight equalling that of an ordinary hornless bullock's hide. The smaller sized Tapir therefore clearly has the advantage of thickness of tegument, and both surpass that of the horse.

The anus has above a dozen folds around it and these form radii, with small wedge-shaped pouches between the elevations. Indeed this portion of the perineum has quite a sacculated appearance. Hunter[2] remarks of *T. Americanus*—"The anus is very large, and the common skin of the body terminates all at once in the gut, not becoming gradually thinner and thinner till lost in the intestine; this termination looks like a cut edge in the common skin and is a little scolloped."

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[1] *Trans. Zool. Soc.* Vol. IV. p. 35.

[2] *Essays and Observations*, Vol. II. p. 167.

2. *The Flayed Carcass, Neck-ligament and the Nasal Appendage.*

There was little superincumbent or cutaneous fat to produce plumpness of contour. Notwithstanding this, by a full development of the flesh a certain harmonious configuration of outline resulted. What little fatty envelope there existed was in a thin layer disposed unequally over the shoulders and loins, and this bore very close resemblance to that of a bullock. The flesh had a somewhat darker tint than is usually met with in the Bovidae, and in this particular rather approached that of the Equidae. The hind limb, as low as the knee-joint, when compared with the corresponding region of the fore limb to the cubit, had the advantage of fulness in flesh, but both were powerfully formed. Below the joints spoken of, the limbs were nearly equal in thickness, but the fore leg and foot had very slightly the greater circumference.

As Yarrel[1] has described it in the American Tapir, the *ligamentum nuchae* is composed of three parts. The first and most superficial portion is the narrowest and most cordiform. It has attachment to the tubercle of the occipital bone, between the lateral curved prominences; posteriorly it ends in the inferior and lateral portions of the ligamentum nuchae, joining these at the last dorsal spine. The two deeper portions stretch between the spines of the atlas and the 7th cervial, and then continue backwards to the upper lateral edge of the 12th dorsal spine. These adpressed portions give off shoots to the several median cervical vertebræ, and apparently also dip between the spines of the 1st and 2nd, the 2nd and 3rd, and the 3rd and 4th cervical vertebræ.

The entire ligament appeared to be composed of yellow elastic tissue. Concerning its modus operandi, the first portion very powerfully flexes the neck and head. The second deeper portions act between the vertebræ, and, together with the superficial division, keep up the graceful curve of the neck and back. The elasticity of this nuchal ligament is extraordinary, rivalling that of the Giraffe, of which Quekett[2] records its contraction from 6 to 4 feet on being separated from attachments.

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[1] *Zool. Journ.* IV. 211.

[2] *Trans. Micros. Soc.* III. 46.

Among the whole range of muscular anatomy there is no more intricate[1] and withal harmoniously beautiful construction than that of the trunk of an Elephant[2]. Every movement within the radii of a sphere is it capable of, and from a soft gentle pressure of power it can gradate to a force of immense momentum. The Tapir's proboscis is nearly identical in pattern, only foreshortened, and its constituent elements of a finer texture, so that muscular bundles and tendons are with more difficulty traced. The construction, whilst complex, is nevertheless simple in design, viz. superficially there are layers of lengthened, longitudinal, semispiral fibres; deeply fascicular bundles set in radii, transversely and obliquely, to the long axis of the organ, and partially intercrossing the one with the other, and with the superficial elongate ones. I shall add to Eudes-Delongchamp's[3] account of the myology of the common American Tapir's nasal organ, some remarks on that of the Sumatran species, premising resemblance obtains. My commentary to the preceding best follows my notes of the dissection.

1. Superiorly a long thin strip of muscle springs from the depression betwixt the nasal bone, its cartilage, and the upper inner rim of the orbit. This strip narrows as it proceeds forwards, whilst the fibres mingle with those of its fellow of the opposite side at the anterior end of the nasal cartilage. Hence they run towards the tip of the proboscis where they become more tendinous in structure.

2. There is a very broad sheet of fleshy substance, thin but nevertheless strong, which stretches from the nasal cartilaginous angle, and supra-orbital prominence forwards radially or fan-like upon the flexible snout quite to its termination.

3. Some delicate fibres run round the upper surface of the orbit and descend in front of the foramina occupying the infra-orbital region.

4. Opposite the said foramina a tenuous slip is sent off, which passes to the side of the nasal passage; and the fibres composing it join those of the soft musculo-fatty outer wall of the proboscis.

5. Beneath these there exists a broad and strong muscular band, which partly arises from the orbicularis palpebrarum, but mainly is derived by a flat tendon from the infra-orbital angle. This goes on to the flexible trunk and there spreads itself upon the under surface in a longitudinal direction.

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[1] 30, to 40,000 muscular fasciculi are affirmed to obtain.

[2] Witness Cuvier's and Laurilland's elaborate sketches "*Myologie.*"

[3] *Mem. de la Soc. Linn. de Normandie*, VIII.

6. Another deeper broad sheet with perpendicular fibres springs from within, or beneath the hollow of the nares, and laterally covers the upper borders of the maxillary and premaxillary bone.

7. Furthermore, the narial wall apart from its schneiderian lining is composed of muscular fatty tissue, or a kind of areolar looking substance of flesh and glistening tendinous fibrillae, the softer padding and minute vessels filling the interstices so as to give homogeneity.

The other muscles of the mouth and cheeks will be subsequently referred to along with those of the neck and head.

Now as to the homology of the above seven divisions the first (*Py* fig. 1) undoubtedly is that spoken of by Cuvier[1], Owen[2], Turner[3], and Delongchamps as the special levator, the "l. rostri" of the latter author, and of Veterinarians. To my reading equivalent to the pyramidalis nasi of the human subject, here however elongated, and with a position of origin corresponding to the alteration of the bony parts. The second broad sheet would correspond to the Levator labii superioris alaque nasi of man, &c., (*L. lsan*) the so-called naso-labial retractor in the horse, and the equivalent of Cuvier's[4] "muscle longitudinal anterieur" in the Elephant's trunk (a pyramidalis nasi possibly being incorporated with it?). Of the third set of fibres in the Tapir these seem to agree with the levator anguli oris. The fourth, from position and function, may best be compared with the compressor naris or triangularis of human anatomy. In sequence that numbered five characteristically is to be homologised with the muscle in man, termed levator labii superioris proprius (*L. sp*); its origin, insertion, and function being identical in *Rhinochoerus* as in *Homo*. Studied with respect to the muscles of the trunk of the Elephant, the present, third, and fifth muscular series would lead to the inference that they are the counterparts of what Cuvier has figured as the "Muscle lateral dirigé de haut en bas et de dedans en dehors[5]" and "Muscle posterieur dirigé de haut en bas et de dehors dedans[6]." Of the sixth muscle in my dissection that known in the human face as the depressor alae nasi most coincides with it. In the Elephant it may be incorporated with what is recognised as the inferior longitudinal muscle, otherwise it is not differentiated in that animal. Lastly, as regards the seventh provisional division, or the deep constituents of the narial wall, viz. muscle, tendon and fat, these require much minute examination and careful unravelling to elucidate their complex nature. Substantially they resemble the radiate and the transverse fasciculi so ably figured by Cuvier[1]. I believe them to be, in both animals compared, enlarged homologues of the several minute muscles and irregular fibrillæ, naso-labials, &c., connected with the alar cartilages and upper lip in the human nose. They are the same which in part constitute the patulous nostrils of the aberrant Saiga[2]. I have furthermore traced them, with still more remarkable changes, in the Sirenia[3] and Cetacea[4]; in the latter helping to form an immense premaxillary mass of muscle, fat, &c., which stretches deeply from the blowhole forwards.

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[1] *Leçons.* [2] *P. Z. S.* 1831, p. 168. [3] *P. Z. S.* 1850, p. 105.

[4] "*Myologie*," Pls. 274 to 280, and lettered in the latter transverse section *a, a, a, a.*

[5] *Ibid. b, b, b, b,* Pl. 280 and Pl. 279, fig. 2, No. 5; also more fully delineated though unlettered in Pl. 276.

[6] *Ibid. c, c, c, c,* Pl. 280, and well shown unlettered, fig. 2, Pl. 278.

Finally, I may remark, how varied are the changes of facial expression from the human being to the Tapir, yet the individual elements of man's nose and the latter's proboscis bear evidence of similitude in their diversity.

Within the nares there is a formation of parts of an unusual kind. Cuvier[5] has curtly limited the topographical relations, but Turner[6] more fully pointed out the structures in question also in the American Tapir. His observations show that the deep notches situate alongside and partially behind the nasal bones are not muscular pits, but curvilinearly afford a nidus for the lateral cartilages which form a dilated blind extremity or pouch lodged in the said notch. My examination of the same species and of the Sumatran animal in the main certify the correctness of his statements, though of the latter creature I may add a few remarks thereon. In further illustration to Turner's diagrams, I append two sketches I made; one, Fig. 8, Pl. x. a semi-dissected fore-segment of the head with the fibro-cartilaginous canals and sacs *in situ* as seen from above, the other displaying the interior nasal passages from behind, separated from the skull with the left convoluted cartilage, gutter and sac opened out, the septum nasi being severed vertically. Extending backwards from the anterior soft nares each canal lies upon the upward splint of the maxillary, and bending round the nasal ends in the bulbous expansion situate betwixt the frontal and nasal bones. Thus the two passages together possess a heart-shaped outline enclosing the adnate pair of nasals. I observed, moreover, that there existed a kind of everted tuck, or what may be supposed rudimentary subsidiary external pouch about the middle of the canal. The entire passage has a moist mucous lining, but I did not detect any special glandular apparatus.

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[1] *Loc. cit. d, d, d, d,* and *e, e, e, e,* Pl. 280, and others.

[2] *P. Z. S.* 1870, p. 481.

[3] "On the form and structure of the Manatee," a Memoir read before the Zool. Soc. 1870, but still unpublished.

[4] Vide *Journ. of the Linn. Soc.* xi. p. 148, and Pl. 5.

[5] "*Leçons d'Anatomie comparée.*"

[6] *Loc. cit.* p. 104, figs. 1 and 2.

The precise function of the two canals and double pair of loculi I am not in a position to discuss with suitable physiological evidence: their homology to me is more apparent. Heretofore[1] I have enunciated that from position, relations, and general structure they correspond in many ways with the Cetacean spout-hole diverticuli. The Tapir's posterior curved canal, as I conceive, is representative of the posterior curved nasal pouch of Whales, what I have termed the naso-frontal sac (*nf* fig. 9). The secondary depression, or loculus, mentioned by me above, may be equivalent to a rudimentary maxillary sac, lateral pouch of Ceti, or to my so-called facial occasional division of the naso-frontal sac; its imperfect character giving no very decided clue, though from what obtains in the ruminant Saiga[2] preference might be given to the former of these. It remains for me, therefore, but to say here that the extra nasal sacs are relatively simple in the Tapir, more differentiated in the Saiga, and complex in Whales.

3. *Notes on the Visceral Organs.*

The examination of the Thoracic cavity exhibited the residual effects of pleurisy, there being fluid exudation, and adhesions between the parietes and the lungs. The latter were congested and exceedingly friable. The disease I conjectured had been caught on board ship, very probably resulting from the inclement weather of the low latitudes which are visited as vessels veer south in following "the great circle sailing." In the transport of large mammals from tropical climes, care should be taken to provide suitable accommodation, &c., for excessive changes of temperature and weather.

The heart weighed 2 lbs. 3½ oz. Diameter at base 7, and length from tip to base 7½ inches. It corresponded to Owen's[3] description of this organ in the American species, and Poelman's[4] account of same in the Sumatran animal, the admeasurements, however, differing from the latter. Length of the trunk of the arch of the aorta 3 inches. It then divides into two, of which one, the larger, turns to the left forming the descending aorta: that to the right is about half the others' calibre, and at ¾ inch gives off the left subclavian artery. The remainder of the branches are in accordance with the Belgian Professor's description and figure.

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[1] The Anat. of *Globiocephalis*, *Zool. Trans.* read 1867, as yet unpublished by the Society:—On Risso's Grampus, *Camb. Journ. of Anat. and Phys.* v. 118:—On the White-beaked Bottlenose, *Journ. Linn. Soc.* v. 141.

[2] *P. Z. S.* 1870, p. 478, fig. 8.

[3] *P. Z. S.* 1831, p. 163.

[4] *Mem. Acad. Roy. Belg.* "Sur le Tapir Indien."

The Stomach did not quite correspond with the above figure, where it has the œsophagus and intestine of about equal diameter. The intestine in our female being fully twice the diameter of the cardiac portion of the œsophagus. Furthermore, the pyloric portion of the stomach curved more towards the cardiac end, thus causing the lesser curvature to be smaller than depicted. The mucous and muscular coats are, as Poelman states, but the glandular portion is deficient at the pyloric and cardiac ends, being spread over the middle region.

Considerable importance has hitherto been attached to the presumptive fact of the proportional difference of intestinal length and cœcum in the Sumatran and American Tapirs. Yarrel[1], for instance, calculates the length of gut to body in the former as 11 to 1 and in the latter 7 to 1, the capacity of the cœcum varying as widely. Without denying diversity in the above respect in the two species, I herewith wish to shew that the deduction is manifestly based on imperfect data, and furthermore assert that the alimentary canal's length depends quite as much on age, sex, &c. as on mere specific distinction. I have compiled the undernoted tabular view to demonstrate this point, Poelman's French being converted into English measurement.

	SUMATRAN TAPIR.			AMERICAN TAPIR.		
	Murie.	Poelman.	Home.	Murie.	Turner.	Owen.
	♀ ad. ft. in.	♂ ad. ft. in.	♂ ad. ft. in.	♂ yg. ft. in.	♂ yg. ft. in.	♂ ad. ft. in.
Length, small intestine	37 5	54 1	69	28 —	35 —	45 —
„ great intestine	11 2¾	13 11⅛	19 6	4 7	——	9 —
„ of the cœcum	— 13½	— 14¾	1 —	— 10	1 1	1 3

The valvulæ conniventes and peculiar sacculate rugæ of the colon have been sufficiently commented on by others. I shall only add that besides the latter Cetacean character I observed, specially marked in *T. americanus*, structural conformation smaller but very similar to what Dr Cobbold[2] has described as the ileo-cœcal gland in the giraffe.

[1] *Zoological Journal*, IV.

[2] *Edinb. Phil. Jour.* N.S. III. 1856.

Spleen non-adherent to the stomach, but partially attached by a portion of the gastro-splenic omentum 1¼ inch from its outer wall; the remainder floats free. Weight, 14¾ ounces. It resembled a bullock's in colour and size. Measurements, 21 inches long, 5 inches broad, and about one-half of an inch in thickness. There are no lobules in the Kidneys, as Clift[1] has observed; on section eight malphigian were counted. The right renal organ weighed 13¾, the left but 13 ounces. Latter slightly the shorter and broader of the two.

In Fig. 7, Pl. IX, I give a sketch of the Liver, an organ not hitherto pictorially represented (to my knowledge) in the Tapir's anatomy. In this Sumatran animal it weighed 6 lbs., and had a granular appearance. Its length was considerably greater, and its breadth less than Poelman has recorded, and the relative magnitude of the individual lobes did not agree with his account. In the main Owen's description and Yarrell's short notice of the liver of *T. Americanus* coincide with what I have found both in the same species and *T. Sumatranus*.

The left lobe has the advantage of size, the middle next, and the right a trifle less than either. Both right and left lobes are wanting in marginal clefts: the middle or cystic lobe has several. Deep lateral fissures exist between the middle and lateral lobes. A tongue-shaped lobus Spigelii is present, and a lobule lying upon the Vena cava may correspond with the so-called lobus caudatus.

4. *A Review of the Muscles*[2].

FLESHY LAYERS OF THE TRUNK, EXTERNAL AND INTERNAL.

a. In Cuvier's illustrations the cutaneous layer (*Muscles peauciers*) is delineated as consisting of three portions: "Thoracico-facien" (No. 4), "Portion scapulaire" (5 a), and "Portion latérale" (5 c). Strictly speaking, this triple division embraces what is ordinarily known as the Platysma myoides, and Panniculus carnosus. The latter in our animal does not invest the entire trunk as in the genera *Sus* and *Hyrax*, and even is more limited than in *Asinus* and *Elephas*, though agreeing with *Equus Zebra*. It has a long pyriform shape athwart the side of the chest, from the broad end of which a dense aponeurotic fascia runs downwards into the hollow of the flank, and upon the side of the knee-joint (Pc^1) enwrapping the muscles thereon[1]. Above fleshy, it is attached (Pc^2) to the middle of nine of the last ribs missing the (10th) hindermost. Anteriorly narrow (Pc^3), it mingles with the fibres of the latissimus dorsi and pectoralis major, terminating by fascia spread over the side of the forelimb. This fascia extends beneath the deltoid to the cubital region, and furthermore mingles with the superficial fascia of the lower limb.

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[1] Foot note p. 169, Hunter's *Essays and Observ.* II.

[2] Appertaining to this subject, the literature (so far as I am aware) is to be found in three publications; Vrolik issued a memoir (*Recherches d'anat. comp. sur le Babyrussa*, Amsterdam, 1844), wherein he made a few comparisons of its myology and that of the Gnu, the Zebu, and American Tapir. Turner's succinct paper (as already quoted, 1850, p. 106) contains brief remarks on the hyoidean and limb muscles of the latter animal. About the same time the posthumus "Recueil" of Cuvier was issued. It contains 6 figures from sketches by himself, evidently of a young (doubtless the foetus glanced at in his "*Leçons*") animal, and one figure designed by Laurillard: all seven are

The greatest power of this muscle seems to reside in the hinder portion, which thus would have a more direct influence in bringing forward the hind leg than in retracting the fore one. This is brought about by the fibres being thickest and broadest at the flank, and the line of force is increased by their somewhat semi-lunar direction and strongly fixed insertion into the ribs; they also powerfully support the abdominal region, and in some degree raise the hind limb. Besides being weaker and narrower, they are straighter from the ribs to the anterior insertion on the outer aspect of the fore limb; the line of action being nearly coincident with the axis of the body.

The portion of the dermal muscle which represents the *platysma myoides* consists of a third broad fleshy sheet covering the masseter and in part the mandible, stopping short at the anterior third of the horizontal ramus. Aponeurosis fastens it to the zygomatic arch and interblends with the *zygomatic* and *orbicularis oris* muscles. It is noticeable also that a strong roundish tendon of the above zygomatic portion attaches itself

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mainly in outline (*Des Planches de Myologie*, Plates 320—323). The lettering indicating muscles has been loosely put in by A. Focillon; and no descriptive text accompanies the plates, Cuvier's sparse remarks in his "Leçons" alone being applicable. From the above it follows that a fair account of the musculo-tendinous distribution in the Sumatran species is legitimate; whilst I shall not lose sight of the labours of preceding anatomists.

[1] Alluded to by Vrolik in *T. americanus* "*Recherches*," cited p. 226 as "*tenseur de la fascia lata*."

to the anterior and inferior edge of that bone. This division, therefore, corresponds to the extra-superficial layer of the masseter in some Rodents[1].

The *Trapezius*[2] (*Tz.*) has a usual situation, and reaches almost from the back of the skull to the 8th dorsal spine. It is very fleshy, and the nuchal portion is firmly adherent to the rhomboid muscle and strong ligamentum nuchae. Remains of a slip apparently of this muscle ran towards the paramastoid; but as this was partially destroyed during the process of flaying I speak of it with uncertainty. In the Tapir the trapezius fixes the scapula as a hinge in movement of the fore limbs; its posterior segment retracting the same. The active power of bending the head, inasmuch as this muscle is concerned, is limited; but this deficiency is amply compensated for by the strength of the ligamentum nuchae.

Rhomboideus[3], single fleshy, narrow from the scapula, and coming well up to the middle of the back. Derivation, mid-neck upon the ligamentum nuchae, backwards. Implantation the scapula, fully a couple of inches broad, and opposite the triangular spot at vertebral border. It approximates the blade-bone to the spine, and produces tension of it forwards.

Serratus posticus very long, as in Hyrax[4]. It may be said to be divisible into two[5], which would represent an anterior and inferior portion, which are nevertheless in the main continuous by fascia, though their insertions with relations to the ribs are different. Its origin, taken as a single one, is by an extensive aponeurosis the whole length of the back, from the lumbar fascia as far as the most anterior dorsal vertebræ to the splenius. This fascia binds down the long dorsal muscles, and ends in pointed, triangular, elongated serrations. The insertion of the first portion, or serratus posticus posterior (*S. p. p.*), is by seven triangular fleshy slips, that are affixed to the posterior margins of the same number of last ribs, reaching about midway between the sacro-lumbalis at its outer border, and the upper border of the panniculus carnosus. The insertion of the second portion, or serratus posticus superior of man, is by seven similar tongues, into the anterior borders of the same number of ribs; but the seventh rib from behind has one tongue on each side, viz. one from each. Thirteen ribs in all therefore have attachments.

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[1] As a peculiarity, I observed above the outer meatus a dense cartilaginous ovoid disk 1½ by 2 inches in diameter and about a quarter of an inch thick. This lay closely applied to the temporal muscle, but interlarded by additional glandular-looking muscular fibres of a strong character. Owen (*Trans. Zool.* IV.) mentions that a similar buccal cartilage exists in *Rhinoceros indicus*.

[2] Cuvier's, *Dorso sus acremien*, lettered a, a^1, a^2, fig. 1, Pl. 822.

[3] *Portion du Dorso-trachelien*, c^1, c^2, Pls. 320, 322.

[4] Murie and Mivart, *P. Z. S.* 1865, p. 335.

[5] Laurillard's, Pl. 320, *Dorso-costien* 10, and *Lombo-costien* 11.

The dorsal part of the *Serratus magnus*[1] (*S. mg.*) is immensely thick and fleshy, but it thins considerably as it passes to the chest. It is continued tolerably strong forwards on the side of the neck, being attached to the 7th to 3rd vertebral transverse processes. A portion is inserted in the deep interspace between the serratus posticus anterior and the splenius. The scapular attachment is wide and firm, so as to produce considerable power of slinging the body of the animal.

Latissimus dorsi[2] (*La. d.*) short, moderately broad, thick and strong in the axillary region. Of a fan shape, it lies on the side of the chest, stretching from the 9th rib below, forward and upwards, to the edge of the scapula and by fascia to the dorsal spines above. Here it is covered by the trapezius. It is inserted into the lower edge of the teres minor; both muscles proceed in union to the humerus. There they lie lower than the twist of the brachialis anticus, are placed above the short head of the triceps, and are covered by the coraco-brachialis, terminating in the inner tuberosity or bicipital ridge of humerus. The very powerful humeral slip and tendon must be of great assistance in retraction of the limb; whilst the enormous dorsi-epitrochlearis derived from it raises the lower segment of the limb, and drags it backwards through the continuance of fleshy fibre of the main portion of the latissimus.

Pectoralis major[3], a moderate, somewhat quadriform mass of coarse fibres, which have a direction crossways from the side of the thorax to the arm as far as the elbow. It is fixed to the sternum opposite the 3rd rib, and forwards to the point of the manubrium. Outwardly it lies upon the surface of the muscles of the upper arm, from the shoulder to the internal condyle. The p. major is in close relation beneath with the p. minor, which latter is much the larger. Anteriorly its margin joins the cephalo-humeral, and it hides the thoracic portion of the sterno-scapular.

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[1] *l. c. Scapulo-costien g*, Pl. 320 and fig. 2, Pl. 322.

[2] *Grand dorsal*, I. fig. 1, Pl. 322.

[3] Cuvier's *sterno-humerien* portion sternale j, Pl. 323, fig. 1; not, however, Laurillard's, fig. Pl. 320 j.

Its very thin fibres prevent its having such power as this muscle generally has, but the p. minor being more developed in a manner takes its place. Its chief action seems to be the approximation of the limb to the thorax, with a moderate movement of the limb backwards (flexion); this is thrown forward, as in walking, &c. As distinguished from the preceding, the Pectoralis minor[1] (*Pmi*) is, on the contrary, unusually large[2]. It covers the surface of the sternal cartilages and ribs from about the 2nd to the 10th. Its fibres are finer in grain than that of the p. major, and as they taper towards the axilla have a slight twist, so that those from behind outside come to be undermost, and those at first in front uppermost, or most superficial.

What Mr Mivart and I recognise as the *Sterno-scapular*[3] muscle in Hyrax[4] is in *Rhinochœrus* well-developed, and with a somewhat looped figure. Origin, vertebral angle, scapula close to the levator anguli scapulæ, it broadens as it approaches the shoulder-joint, and is attached by fibrous tissue and fascia to the cephalo-humeral and pectoralis minor muscles. Thence it diverges towards the side of the thorax, spreading out as it fixes itself to the three anterior ribs and fourth sternal cartilage, but is not attached to the manubrium. From the curved course of this muscle it has a raising and protracting action on the limb, or, according to the fixed point, would drag the body forwards. At the same time the muscles of opposite sides, along with the serratus magnus, slings the body on the pivots of the fore limbs.

The muscle now well known as the *Supra-costal* in the Sumatran Tapir is identical with what obtains in the Zebra, Giraffe, &c. It appears almost as if a continuation of the scalenus anticus. It is derived, however, by a flat tendon, 1¼ inch broad, from the 1st rib, and proceeds to the cartilage of the 4th and the adjoining portion of sternum. Previous to reaching the latter it crosses the rectus abdominis. The *internal intercostals* occupy at least seventeen rib interspaces, and probably eighteen, but the latter is somewhat doubtful. Commencing about the angle of the ribs the external intercostals stop short a little way above the commencement of the sternal cartilages.

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[1] Portion costale *sterno humerien*, j^1, fig. 2, Pl. 323, and j by error, Pl. 320.

[2] Vrolik describes the long pectoral fibres (above referred to) in the Babyrussa as P. minor, by some considered as a second part of the P. major.

[3] The petit pectoral, costo-coracoïdien, Cuv. *f.* fig. 1, Pl. 323. It is the sous clavier of Vrolik in the Babyrussa, p. 221.

[4] *Loc. cit.* p. 338.

In this as well as many other mammals the *Triangularis sterni* is rather to be compared with the dorsal serrati than the figure implied by its name. It extends from the 2nd to the 7th ribs clearly, and then fibres go on from cartilage to bone for the rest of the floating ribs; although the latter might be considered as a continuation of the transversalis abdominis. The 1st rib is free from this muscle, as in man, the interspace being filled with an extension of the deep cervical fascia, the vessels passing between it and the bones.

The elastic fascia of the *External Oblique*[1], which connects it with the ilium and pubis, is very strong; it occupies the angle, bounded by the medial line, the anterior rim of the ilium, and the pubic symphysis; the tendinous fascia running down the middle line of the latter an inch or two. The fascia on leaving the ilium is firmly attached to the conjoined psoas and iliacus as they pass out of the abdomen, and then continues more loosely fixed to a strong slip of aponeurosis, derived from the internal oblique. Muscular fibres extend only from the outer border of the broad rectus; the interval between each in the median line being occupied by an immensely thick, yellow fibro-elastic sheet. There are fourteen serrations into as many of the last ribs; the four anterior ones interdigitate with the hindermost five of the Serratus magnus. Peculiarities of attachment and trifid semi-division were noticeable in the *Internal Oblique*[2]. A strong tendon from the ilium forms a fan-like sheet superficially for some inches; muscular fibres diverge forwards to ribs and towards the median line of abdomen. Midway between ilium and ribs it separated, and the smaller, stronger portion goes to the last and tips of cartilages of last two ribs. The other broad flat belly stops short of the rectus, and reaches no further back than opposite the crest of ilium, while forwards a wide interspace exists between its border and the rib cartilages. The terminal aponeurotic tendon of the internal oblique nearly all crosses the rectus; the anterior portion, which in man passes behind, in the Tapir is attached to the border of rectus, and reaches forwards to the 13th or 14th rib-angle. The *Transversalis* covers internally 9 or 10 rib-cartilages, and its fibres cross the anterior half of abdomen; posteriorly it widens as an aponeurotic fascia. The *Rectus abdominis*[1] is derived by strong broad tendon, far back on the symphysis; 5 inches forwards it becomes fleshy, and with great breadth to the chest enters, whence it narrows extremely, and by flat tendon is fastened to the 1st rib. Increment of strength to this muscle in the abdominal parietes is gained by an aponeurotic fascial strip, which traverses the costal cartilages and interspaces from the internal oblique. There is no *Pyramidalis.*

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[1] *Costo-abdominien*, Pl. 823, fig. 1, No. 13.

[2] *Ileo-abdominien*, 14.

Considering the actions of the abdominal muscles, the rectus appears to be the main central support of the viscera, inasmuch as the fibres are thickest, and it is also remarkably broad. The one outer half of the internal oblique drags the ribs backwards, while its abdominal portion is the great contractor of the outer end of the lateral abdominal walls. The external oblique acts reversely to the latter, or rather intersects it diagonally, but although slanting in direction, it drags back the ribs and also supports the viscera. The muscular fibres of the transversalis being short, it acts mainly on the forward half of the abdominal parietes.

The *Psoas parvus*[2] arises by a short tendon from the last three ribs at their vertebral junction, and afterwards has a considerably sized belly, upon the surface of which a flattened tendon commences about opposite the second lumbar vertebra. This terminates round and strong at the brim of the pelvis, midway between the ilium and acetabulum. The *Psoas magnus* is very broad and arises from the same point outside of the above. It covers the transverse processes, also the side of the vertebræ, and joins the iliacus. It has a superficial tendon half its length. The *Iliacus* is also very broad and fleshy, it has origin on the surface of the ilium and along with the psoas magnus is inserted into the femur.

[1] *Sterno-pubiens*, 15.
[2] *Psoas et Iliaque réuni*, h + i, fig. 1, Pl. 323.

Sacro-lumbalis (*s. l.*) comparatively broad and rather strong[1], as is the *Longissimus dorsi*[2]. Large and fleshy, the *Spinalis dorsi*[3] goes as far forward as the spine of the fourth dorsal vertebra. *Semi-spinalis dorsi* is uncommonly voluminous, so that at first sight it might be taken for part of the *Spinalis dorsi*. It arises in a V-shaped manner, from the eighth large spine, filling the interspace of the fifth and sixth where the spinalis dorsi narrows, and then becoming much thicker and fleshy, tapers at its anterior end into the foremost dorsal or cervical spine. The *multifidus spinæ*[4] are thick, filling the hollow between the transverse processes and spine of the vertebræ; they have a similar origin and insertion as in man. Five *interspinales* exist between the long spines. One belongs to the last cervical and four are dorsal. The remainder of the dorsal spines have apparently only strong fibrous tissue in their interspaces.

MUSCULO-TENDINOUS PARTS OF THE ANTERIOR LIMB.

b. As in Hyrax the *Subscapularis*[5] (*S.*) does not cover the entire inner surface of the bone. At its insertion the small but strong tendon of the coraco-brachialis crosses it playing in a bursal groove. It may be remarked of the teres major[6] (*T. ma.*), that besides bringing the scapula and humerus in nearer approach, it, along with the subscapularis, forms a *point d'appui* for the latissimus dorsi of dorsi epitrochlear to act upon the lower limb from the olecranon process. There is a partly double *teres minor*. The second head by a short strong tendon springs from a pit beneath the glenoid cavity: 2 inches from its origin it is joined by the first longer head, the two being fixed to the tuberosity above the deltoid. The *supra spinatus*[7] (*S. sp.*) is broader than the fossa, and the *infra spinatus*[8] (*I. sp.*), though narrower, is equally strong. Increase of breadth of the shoulder muscles is due to the sterno-scapular element. The two former are powerful levers of the fore limb. The first plays as a pulley upon the upper extremity of the humerus retracting the head of the bone and thus throwing out the leg with force. The second, besides this action spoken of, which otherwise could be partly subdued or impeded, gains further purchase through the prominence, and in consequence has also the duty of rotating the limb outwards by the additional fulcrum.

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[1] C. fig. 2, Pl. 322, "Myologie."

[2] B. *loc. cit.*

[3] A. *loc. cit.* figs. 2 and 3.

[4] Partly shown in fig. 3, Pl. 322, H.

[5] *Scapulo-trochinien*, n, fig. 2, Pl. 323.

[6] *Scapulo-humerien*, O.

[7] *Sus-scapulo-trochiterien*, l, Pl. 320, and fig. 2, Pl. 323.

[8] *Sous-scapulo-trochiterien*, m, Pl. 320.

The *Deltoid* (*D.*), as in the Ungulata and Hyrax, is both altered in position and relative size to the muscles of the shoulder. It is similarly composed of two long and narrow slips. The lowest, longest, and largest portion arises from fascia over the infra-scapular muscle, and also from the most inferior border, by a very strong aponeurotic tendon, and is inserted along with the smaller slip of the muscle, but form the main and deepest body of the very strong ligamentous tendon. The superior smallest slip lies between the last and the insertion of the infra-scapular muscle. It is narrow, short, and somewhat flattened, deriving its origin from the inferior anterior third of the infra-scapularis. Broadening as it descends it covers considerably the insertion of the first portion of the deltoid. The comparative diminutive volume and position of this muscle prevents it from having any very great influence in the movement of the limb. But it steadies the limb and may counteract or aid the cephalo-humeral.

Dorsi epitrochlear (*D. ep.*) This triangular muscle[1] is entirely fleshy, and although only moderately thick is nevertheless wonderfully strong by reason of its great breadth at the base, viz. between 5 and 6 inches. It is derived from the Latissimus dorsi, and distant fully a couple of inches from the shaft of the humerus. Insertion: the olecranon and inner condyle, its fascia is moreover continued down the forearm. Through the long lever of the Latissimus dorsi, the dorsi epitrochlear would seem also to be an antagonist to the triceps (its scapular head), and rotate the limb inwards.

The Sumatran Tapir agrees with *Hyrax Capensis*[2] in possessing four bellies to the *Triceps*[3] muscle, besides the last-mentioned. In the latter animal the fourth part is differently inserted, namely, into the inner condyle and the olecranon, whereas the animal under present consideration has it filling up the posterior intercondyloid fossa rather than as a point of origin. This extra head in the Tapir can hardly be the anconeus[1], which is a continuation of the triceps, whereas that in question is essentially a quadricipital division sui generis.

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[1] t^3 Cuv. Pl. 323, fig. 2.

[2] *Loc. cit.* p. 340.

[3] *Recueil*, t, t^1, t^2 *Scapulo-olecranien.*

Biceps (*B.*). Strongly muscular and single-headed[2]. Tendon of origin powerful, fixed to the coracoid process, its outer surface being joined by that of the coraco-brachialis. Insertion, the inner surface head of radius. The cephalo-humeral covers its tendon while lying on the occipital groove. It rotates the limb very slightly outwards, besides flexing it. The coraco-brachialis would rather rotate it inwards, but also very imperfectly. The brachialis anticus and biceps are powerful flexors; taken together they embrace the humerus in a V-shaped manner. Relatively speaking, the *coraco-brachialis* (*C. b.*) is of considerable volume, and with a single strong tendon of origin is derived from the coracoid process in conjunction with the tendon of biceps. Opposite the shoulder-joint it spreads out into a broadish muscle, which is continued muscularly down the inner and front sides of the shaft of humerus, its lower 3rd-fourth, the biceps covering a great part of its insertion[3]. The conjoined tendon of Teres major and Lat. dorsi reaches higher than its upper edge of insertion, but also is fixed behind and below the same edge. Like what obtains in many Perissodactyla, the *Brachialis anticus*[4] (*B. a*), has a high post-humeral[5] derivation and radial termination inferior to that of the biceps. The insertion of these two occupies nearly the upper third of the bone, and by fascia they are continued to the ulna.

The *Supinator longus*[6] (*S. l.*) is a riband-like muscle, lying closely adherent by fascia to the next two to be described, but mainly on the ext. carp. longior. It arises from the highest point of the (three) outer supra-condyloid ridge, and winding round the forearm upon the surface of the two mentioned extensors, is inserted by a flat, strong tendinous fascia to the inner but anterior prominent edge of the lower end of the radius, part of the tendon extending to the styloid process. *Supinator brevis* absent.

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[1] It does not correspond with Cuvier's *Epicondylo-cubitien*=*Anconé externe*, as depicted in fig. 2, Pl. 323 u, which is strangely placed on the inner aspect of the limb. Turner says the anconeus is wanting or confounded with the triceps, *l. c.* p. 106. Vide *Anconeus epitrochlearis*. J. Wood, Var. Human Myol. *P. Roy. Soc.* 1866—8, and authorities therein quoted.

[2] As Vrolik mentions. Cuvier's *scapulo-radien*, r.

[3] Turner notes in the American species its nearly reaching the inner condyle, *l. c.* p. 106, corroborated by Cuvier, fig. 2, Pl. 323, q; and both, along with Vrolik, agree as to its single belly.

[4] *Humero-cubitien*, s, Cuv.

[5] Alluded to by Turner and Vrolik, whilst the latter notes as peculiar that in the Babyrussa the Lion and Zebu there is but one fascial insertion into radius of this muscle and the biceps.

[6] *Humero-sus-radien*, v. *Recueil.*

The *Extensor carpi radialis longior and brevior*[1] (*E. c. r. l.* and *b.*) are so interblended in their tendons and muscular fibres, that it would be hazardous to say they exist as distinct, but for the circumstance that a flattened broadish tendon springs from the anterior intercondyloid fossa, and this might represent the extensor carp. brevior, while the main origin of the united muscle arises broadly by fleshy fibres the whole length of the outer condyloid ridge. Together they end about the lower end of the anterior surface of the radius in a very broad and strong tendon, which passes through the innermost broad groove of the wrist, being overlain by the ext. ossis metacarpi pollicis, and terminate by tendon and aponeurotic fascia upon the distal end of the middle (or 2nd-inner) metacarpal bone; a small slip of tendon, however, is given off to the 2nd (or inner) metatarsal, which latter, although it cannot be traced upwards, nevertheless may represent the tendon of the ext. carp. rad. brevior.

The *Extensor communis digitorum* of the fore limb (*E. c. d.*) is large and very powerful. Origin, by a bulky tendon intermixed with muscular fibres, from the outer condyle, and intermuscular fascia, the latter also connecting it with the outer side and front aspect of the head of the radius. It is fleshy to the proximal end of the next joint, especially on the inner margin. About the middle of the anterior edge of the ulna there is derived an additional diminutive slip of muscular fibres which joins the larger belly of the muscle above the wrist. The tendon of the extensor com. dig. is very broad, flat and strong, and proceeds expanding onwards to the distal end of the metacarpals, where it divides into three divisions[2], which cover the dorsal superficies of the 2nd, 3rd and 4th digits (*i.e.* the three inner ones) to the proximal ends of the distal phalanges.

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[1] *Humero-sus-méta carpien, loc. cit. δ*, apparently single.

[2] The outermost digit receives a tendon in Cuvier's Pl. 322, fig. 1. *Epicondylo-sus-phalangettien ε.*

Extensor medii digiti (*E.me.d.*) and *Ex. minimi digiti* (*E.m.d.*^{1,2}). Under this heading I group three muscles more or less united at their origin. Collectively they arise from the external condyle, the inter-muscular fascia, the head of the ulna, and the ridge of the ulnar shaft, nearly its whole length. Previous to dissection they seem but one long belly and tendon, which latter below at the distal end of the outer metacarpal forms a flattened expanse of immensely strong fascia. Unravelled, what I term the ext. med. digiti separates about the wrist, and with a broadish tendon proceeds to near the outer digital fork, where the tendon splits and supplies the two outermost digits (III. and IV.). The external divisions, or what more nearly correspond with ext. min. digiti, have two main tendons below; one of these goes solely to the outer (IV.) digit, the other proceeds chiefly to the same digit, but moreover partly is sent on to the third digit, and has beneath it a cartilaginous disk. Above this duplicate, ext. min. dig. resolves itself into four constituents. Of these, that denoted as 2 fig. 3, is a diminutive musculo-tendinous strip, which adheres close against the ex. med. dig. (1); a very long delicate tendon represents 3 and is adpressed to 4, also a longish tiny but muscular belly. These three small differentiated parts unite below into one tendon, the equivalent of the fourth constituent (marked 5), which respectively form the dual Ex. min. dig.[1]

The *Extensor ossis metacarpi pollicis* is of considerable volume, but not so broad comparatively as in some animals. It arises from the interosseous membrane and the adjacent sides of the ulna and radius, and is fleshy to within the groove common to it and the ext. carp. rad. long. and brevior. It forms immediately beneath this a very strong tendon which curves inwards and forwards to be inserted into the inner surface of the indicial (or inner) metacarpal bone; portion of its aponeurotic fascia has also an attachment to the *Extensor primi,* and *Secundi Internodii,* and the *Extensor indicis,* as in Hyrax, are all wanting. The *Extensor carpi ulnaris* (*E. c. u.*) is larger and stronger than the ext. min. dig. It arises from the ext. condyle behind the last, and partially from the olecranon process at the styloid process of ulna, where it becomes a single broad tendon fixed into the proximal end of the 5th (outer) metacarpal bone. This muscle has a deep sulcus in its superficial surface, which when ripped up gives it greater breadth and a kind of double appearance[1].

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[1] The above subdivisions of the outer extensors is suggestive of homology with the peronei. Nos. 1 and 5 would represent the peroneus longus and brevis; No. 4, the peroneus tertius; No. 3, peroneus quartus, and No. 2, probably peroneus quintus, the distinguishing character of the latter according to Huxley being its situation on the front aspect of the bone. Whilst collating the above extensors as E. med. and E. min. dig. there is quite a possibility of their being considered by others as in part an abnormally inserted Extensor indicis and Ext. pollicis et indicis; for variations in which consult Wood's excellent papers in the *Roy. Soc. Proc.* 1866 to 1868.

The distribution of power of the several fore-limb extensors is as follows: the *ext. carp. radialis long.* and *brevis* act upon the middle (2nd inner) digit, as their name implies. The *ext. os. met. poll.* give extension of foot with rotation outwards. The *ext. com. dig.* is a simple extensor of the three innermost digits present, the *ext. min. dig.* of the two outer toes, and the *ext. carp. ulnaris* of the outer (5th) digit, which it may also abduct.

Palmaris longus (*P. l.*), may be said to arise broadly from the inner surface of the olecranon, and continuing muscular for a length of 5 inches, becomes tendinous. This latter is broad and flat, and enwraps the conjoined flex. sub. and profundus above, but the tendon as it advances downwards narrows, and after it passes beneath the pisiform bone is firmly united to the outer side of their conjoined tendon. A portion of its tendinous fascia is continued onwards to the palm, and crossing their surface is lost in the palmar fascia; possibly being continued on to the *flexor brevis manus.* The latter (*F. b. m.*) remarkable muscle, as described by Mr Mivart and myself in Hyrax[2], is very manifest in *Rhinochœrus.* Its fibres occupy the broad palmar fascia, and appear to supply all four toes, being one more than in the form compared[3].

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[1] Apparently applicable to the *Epitrochlo-carpien* and *Cubito-sus-metacarpien,* C, C^1 of fig. 1, Pl. 322.

[2] *Loc. cit.* p. 342, fig. 6.

[3] Just a barely appreciable line of separation is recognisable between the bellies of the flexor sublimis *F. s. d.* (*Epitrochlo-phalanginien,* χ) and flexor profundus digitorum *F. p. d.* (*Portion du Cubito-sous-orguien,* μ) as they run full and fleshy to the wrist, wherefore their tendons are distinct. Those of the latter are by far the broader, and four in number, whilst the former supply but the three inner toes. Besides the fused condylo-ulnar head, a shorter separate

Lumbricales[1] (*L.*), 3 in number, and each with a good long and thick fleshy belly. The first and largest arises from the palmar surface of the deep united flexor tendon about its middle, and proceeding in close connection on the inner side of the tendons going to the 4 digit (2 from outer side) is implanted by a long thread-like tendon into the middle phalanx of the 4 digit on its inner border. The second arises between the deep tendons supplying the 2 and 3 digits, and is inserted by fascia also upon the radial inner side of the 3rd (or 2nd inner) digit. The third has a thiner belly than the other two, but is nevertheless a more powerful muscle than either by reason of its greater length and stronger tendon. It arises from the palmar surface and inner (radial) edge of the deep flexor tendon, but has also a strong attachment to the *radial* (inner) tendon of the flexor sublimis. Passing beneath, and to the inner side of this last, it ends in a comparatively strong tendon implanted into the proximal phalanx of the 2nd (or inner) digit. The 3rd lumbricalis would seem to be able to abduct the inner (2nd) digit besides flexing it, while the other two analogous muscles are simply flexors of the digits. Derived by a short flat tendon from the internal condyle, the *flexor carpi radialis* (*F. c. r.*)[2] with a moderate muscular belly extends half way down the forearm where, with a strong cordiform tendon, it continues to the wrist, gliding in a deep groove on the bone, and being finally inserted. A scant *pronator radii teres* (*P. r. t.*) exists[3], and the *flexor carpi ulnaris* (*F. c. u.*) offers no peculiarity. There is above two inches in breadth of a muscle covered by tendon stretching between the ulna and radius equivalent to the *pronator quadratus* (*P. q.*)[4]. *Abductor minimi digiti* (*Ab. m. d.*). This, as has been noted of some other muscles, resembles the condition extant in Hyrax; it is very distinct and strongly muscular. It arises thin, broad and fleshy from the distal and outer margin of the pisiform bone, where it is adherent to the strong deep palmar fascia; increasing in thickness it forms a thickish belly, which by fascia and tendon passes outwards, and is inserted into the

belly springs from the mid-ulnar shaft and adjoining membrane. This representation of a Flexor longus pollicis (*F. l. p.*) joins the enlarged powerful tendon of the profundus at the wrist and loses itself therein.

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[1] Not referred to by the previous writers.

[2] *Epitrochlo-metacarpien*, γ, fig. 2, Pl. 323 "Recueil."

[3] Turner, *l. c.* p. 106.

[4] Mention omitted by authors.

sesamoid of the 5 (outer) digit. The whole of the *Interossei*[1] of the fore-foot are highly developed, and each composed of coarse strong muscular fibres. There are four pairs ($I^{1,4}$), viz. 2 to each bone. These are somewhat single at their origin, which is from the proximal end of the metacarpals and the deep surface of the carpal bone. The inner (radial) one is larger than the other and its tendon extends along the side of the metacarpal bone to the proximal phalanx, the others are inserted by very strong fascia into the respective sesamoid bones, 2 to each metacarpal bone[2].

THE NECK AND THE HEAD-MUSCLES.

c. *Cephalo-humeral* (*C. h.*). Powerfully muscular and long[3]. Origin partly by muscular tendinous fibres from the outer surface of the para-mastoid, and chiefly by coarse fibres from the outer margin of the lateral process or expansion of the atlas. Towards the shoulder it is narrowish but very solid, and lends thickness to the neck. As it covers the supra- and infra-scapular muscles it expands considerably, becoming thinner and hiding the insertion of the aforesaid scapular muscles, as also the deltoidii, together with the upper part of the brachialis anticus and humeral head of the triceps: insertion upon these last, diminishing in muscular fibres until they intermingle with the outer fascia of the limb.

With the limb fixed it must powerfully flex the neck and act antagonistically to the ligamentum nuchæ. On the other hand, the elasticity of this last, supporting the head and neck, forms a point of force whereby the cephalo-humeral drags forwards and upwards the limb from the shoulder-joint, besides rotating it inwards.

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[1] Neither figured nor described hitherto.

[2] There are besides 3 single interosseous muscles superficial to the last (*S. i.*), the 1st (or outermost) is the largest, and along with its fellows arises from the under surface of the deep palmar fascia. It is inserted by a long small round tendon into the inner side of the middle phalanx of the outer digit. The 2nd single interosseous has a similar origin, and is inserted by a similar tendon to the 1st on the inner side of the digit. The 3rd and smallest single interosseous is more deeply placed between the double interrossei of the 1st and 2nd digits (the inner interspace), and ends as the others by tendon, but somewhat shorter on the outer ulnar side of the 1st digit. In addition to the 7 interossei there is a very small still deeper (or *dorsal ?*) one between the 2 outer digits; this is mainly attached to the inner side of the metacarpal of the 4 digit. The interossei from their very great thickness fill the deep hollow of the plantar aspect of foot, and together with the immensely thick common flexor tendon, flexor brevis manis, and elastic pad, form a solid cushion behind the toes.

[3] Lettered in the "Myologie" d, as the *Trachelo-brachial* of G. Cuvier; and evidently corresponding to Turner's "peculiar muscle," *loc. cit.* p. 106, and Vrolik's *masto-humerien*, p. 222, met with in the Babyrussa, Gnu, Tapir, &c.

Two or three long, strong, rounded, cord-like bellies appear to compose the *Sterno-mastoid.* The first portion or belly, which is probably the strongest, and is the most superficial ventrally, arises by muscular fibres from the manubrium; it terminates in a very strong tendinous fascia several inches long, into the posterior ascending border of the mandible. This portion appears to correspond to what has been described in the Hyrax as the second part or true sterno-mastoid. The second distinct belly is smaller than the last, but of a similar shape. Its manubrial conjoined origin is deeper and more anterior than the first portion, crosses the direction of the latter in the neck, and becoming outermost and above. Its terminal long, narrow, roundish tendon intermingles with the third portion of the muscles, and together they are inserted into the paramastoid process. The third separate belly corresponds to what has been denominated the cephalo-humeral or cleido-mastoid in Hyrax. In the Tapir as it ascends it lies between the pectoralis major and brachialis anticus; and, broadening out considerably, covers the inner surface of the shoulder-joint, and is superficial to the sterno-scapular. It traverses forwards in the neck, becoming cord-like, and lying to the outer side of the two other portions of the sterno-mastoid; and being at last inserted with the second described portion into the paramastoid, its share of the common insertion being mainly muscular.

The action of the sterno-mastoid apparently corresponds to the attachment of each separate belly. The first would flex the head through the mandible, and it may be, also, supply the place of the deficient platysma myoides. The second would also bend the head and neck, but have a less side-movement. The third seems to act according to whether the limb or head be the fixed point. If the head, then the limb can be dragged forwards, the forearm aided in bending, and the whole limb rotated inwards.

The superficial jugular vein makes its exit beneath pectoralis major, goes along the neck between its second and third portion, turns over the surface of the latter, and between it and the first portion sends off superior cervical branches, and continues to the upper post angle of the mandible, piercing the parotid gland.

Thin in muscular fibre the *Splenius*[1] (*Sp.*) covers a large superficies. Its attachments are the ligamentum nuchæ and fascia joining the serratus posticus (anterior). It covers nearly the whole of the deep muscles of the neck, forming with them a bulging prominence almost separated from the dorsal muscles by the manner in which it is bound down, and is inserted apparently into the transverse processes of the six anterior cervical vertebræ. The *Complexus* is also extensive, and forms a sheath or cover for the cervical muscles. Origin, by a strong short tendon from the outer occipital spine, and by a broad thin muscular sheet from the posterior ridge of the temporal bone. Narrowing at the hinder end of the neck and becoming wedge-shaped it is finally inserted into the transverse processes of the seventh or eighth dorsal vertebræ. Its nuchal portion is in close relation with the ligamentum nuchæ, where it is very thick, whilst the ventral side is much thinner.

There are sixteen pairs of *levatores costarum;* it may be seventeen in all, as what has been described as the *scalenus posticus* appears to answer to the most anterior one.

A broad strong slip departs from the preceding muscle, separating from it about the last cervical vertebra, and continuing by itself to the transverse process of the atlas; this is the so-called *levator anguli scapulæ.* A long muscle rather occupies the side of the neck, arising from the transverse processes of cervicals, and becoming broader is inserted into the outer edge of the transverse process (lamina) of atlas, a strong tendon continues on to the paramastoid process at its base. A second muscle of about equal bulk with the above arises from the transverse processes of the 4, 3 and 2 cervical, and is inserted into the posterior angle of transverse process of atlas.

The short deep posterior neck-muscles are each and all fully developed; of these the *rectus posticus major* has attachments to the sides of the spines of the atlas and axis. Smaller by far the *rectus posticus minor* proceeds to the first vertebra. The *superior oblique* has perpendicularly and laterally-placed fibres which proceed from the occipital curved line and paramastoid to the atlantoid laminæ. By far the largest of these nuchal muscles is the *obliquus inferior,* which has ordinary fixed points.

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[1] I. I, Pls. 320, 322 = *Cervico-mastoiden* and *Dorso-trachelien.*

The *rectus lateralis* is truly ventral in position. With a basi-occipital origin the *rectus anticus major* is continued by strong broad tendons inserted into the cervical vertebræ, the second to the sixth. The *Rectus anticus minor* has insertion into the atlas.

Each *Longus colli* is continued within the chest to the third dorsal vertebra, and thence the two muscles cover the entire under surface of the neck. Tendons of attachment fix themselves to the bodies of the 3 dorsal, 7th, 5th, 4th, 3rd and 2nd cervicals, other superficial tendons likewise go to the transverse processes of the 2nd to 5th cervical vertebræ. The *Scalenus anticus* is strong and long bellied, tendons of origin spring from the transverse processes of the 4th, 5th and 6th cervicals; it terminates on the first rib. *S. medius* less bulky, points of origin similar but with a broader insertion; it goes to the 1st and 2nd ribs and intercostal space beyond. A diminutive quantity of muscular fibres occupies the angle between the last cervical and head of 1st rib, and these I take to be the *S. posticus*. The last is represented longest by Cuvier[1].

The *Temporalis* (*Te.*) is thin, but of considerable breadth, and it reaches quite to the cranial crest. Its insertion lines both sides of the coronoid process; a separate tendinous slip of the outer portion proceeds to the alveolar angle. There is no great depth of fibre in the *Masseter* (*Ma.*), but this is compensated for by very considerable breadth. Relatively the *Buccinator* (*Bu.*) is large, and increment gained in thickness by the development of the buccal glands within. This muscle does not descend so far as the inferior border of the mandible.

The broad encirclement of the mouth by the *orbicularis oris* (*O. o.*) is marked, and the fibres of the *zygomaticus* (*Z.*) intermingle with it. No clear line of separation existed between the *external and internal pterygoid muscles*[2].

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[1] Pl. 322, fig. 2, *Trachelo-costien*, 6, 6^a, 6^b.

[2] Turner observes of the American species:—"There is no separate stylo-hyoideus, the digastricus giving some fibres to the os-hyoides. The Tapir also possesses a muscle whose fibres (to use the words of Cuvier) fill a portion of the interval of the two cornua of the same side. There is a double pair of thyro-arytenoid muscles, the upper being partly continuous with the transverse arytenoid muscle, and forming a powerful constrictor of the glottis." My own notes of the neighbouring parts in the Malayan animal run thus:—Each digastric (Cuv. Pl. 323, fig. 1, *q.*) is of considerable size, and its fleshy belly flat and moderately thick. There is no positive median tendon, but along the inner

THE MUSCLES AND TENDONS OF THE HIND QUARTERS.

d. With origin from the anterior iliac process and patellar insertion the *Tensor vaginæ femoris* (*T. v. f.*) has an unusually large and strong muscular belly. This is very thick to the border next the groin, but thins towards the outer aspect of the limb, being there continuous with the gluteus maximus above and biceps below. The three, however, are so interblended in muscular fibre, which is again overlaid by fascia, as to be with difficulty detached from each other. The great strength of the tensor vaginæ femoris render it a powerful extensor of the limb[1]. The *Gluteus maximus* (*G. mx.*) is chiefly aponeurotic, it therefore seems an extension of the lumbar fascia continued on to the spines of the sacral vertebræ[2]. Posteriorly it terminates at the commencement of the caudal vertebræ, but here thickens and lies in a deepish hollow betwixt the posterior border of the gluteus medius and anterior border of the biceps. Its fibres curve with the hip and are implanted by a strong aponeurotic tendon into the third trochanter. The pulley-like action of the g. maximus is very much dependent on its being placed in a deep groove behind the g. medius, where in a manner it is kept in position by the biceps. There is a wonderful depth of flesh in the *gluteus medius.* This muscle (*G. m. d.*) extends in a wedge-shaped manner between the last rib and the ilium; behind it broadens, covering the whole of the dorsal iliac surface and overlapping its outer edge; whilst mesially it is fixed to the sacral spines, and its attachment reaches the biceps. Its fleshy and tendinous insertion is upon the great trochanter besides passing down on either side of it. *Gluteus minimus,* short though strong. Attachments, ilium on front of acetabulum, but no higher than the obturator foramen.

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side and upper half for a considerable area it is tendinous. Origin, whole of the lower surface of the paramastoid; its insertion overlies the posterior half of the mandible partly covering the pterygoid, and with an osseus attachment on the middle third of the lower jaw without advancing to the symphysis. The mylo hyoidei (*Ibid.* letter *r*), from the shape of the digastrici, do not reach the inferior margin of the jaw till within a third of the interspace between the symphyses and the angle. The flesh of the mylo-hyoid is thin. Neither of the foregoing naso-facial and pterygoidean muscles of the Tapir have been figured in the "*Planches de Myologie,*" but Eudes-Delongchamps partially supplies the hiatus in *Mem. de la Soc. Linn. de Normandie,* tom. VII.

[1] Named fascia lata (*Ileo-fascien*) in letterpress Myologie X. in figs.

[2] *Sacro-fémorien* and *Ilio-trochanterien* = G. max. and G. med. a, a[1].

There is a large and thick *obturator externus*[1], and the *O. internus* covers the obturator membrane within and reaches well up the bone of the ilium, its tendon passing out of the pelvis beneath the gemelli. *Gemellus superior*[2]—small—origin, by tendon from the posterior part of the bone at the junction of the ilium with ischium, almost opposite the acetabulum. *G. inferior*, beneath the last, and with similar insertion. The *quadratus femoris* is very little larger than the gemelli, and arises posteriorly to the tendon of the obturator internus. All these muscles go as usual to the trochanteric fossa.

Arising superficially upon the upper surface of the conjoined psoas and iliacus just within Poupart's ligament, the *Sartorius*[3] (*Sa.*) as a narrow band goes downwards and is inserted superficially, but along with the gracilis, over the tuberosity of the tibia. Below the former muscles the sartorius occupies the deep hollow betwixt the adductor magnus and vastus internus, partially covering the adductor as it joins the gracilis. Its diminutive volume gives it little power as an adductor of the limb. It is absent in Hyrax[4]. The *Gracilis*[5] in this instance is a very large thick muscle, and has an origin from three-fourths of the posterior line of symphysis; its fibres run outwards and downwards, and are inserted partly by an aponeurotic tendon into the inner surface shaft of the tibia below the tuberosity. Another portion of the muscle with a separate belly diverges about middle posterior of groin, and proceeds in a divergent line from last down the leg, terminating in a strong round superficial tendon. Action: an inward rotation of leg from below knee and flexor conjoined with os-calcis muscles.

The largest of all the vasti is the *V. externus*[6], which is of unusual magnitude (*V. e.*). The *V. internus* (*V. i.*) presents nothing remarkable. *Rectus femoris* (*R. f.*) single headed, origin by a strong tendon from the front of ilium; insertion patella.

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[1] *Sous pubio-trochanterien externe*, d.

[2] *Portion des Ischii trochanteriens*, e.

[3] Pl. 323, fig. 1, *Ilio-prétibien*, t. [4] *Loc. cit.* p. 347.

[5] Shown but as one flat sheet u, fig. 1, Pl. 323, *Pubo-prétibien*.

[6] m and n. Vast. ext. and int., translated as *portion du Tri-fémoro-rotulien*. The expanse of the former is well displayed in Laurillard's Pl. 320.

The *crureus*[1] is large and muscular, as distinct from the above muscles as in Hyrax. It covers the entire length of the shaft of the femur. The *A. magnus* (*Ad. mg.*)[2], very large and thick, springs from the whole of the pubic symphysis, and femorally is fixed on to the lower half of the linea aspera. The femoral artery does not perforate its fibres, but lies superficial and dips beneath its lower border to reach the popliteal space. What corresponds to the *A. brevis* (*Ad. b.*) is attached to the brim of the pelvis close to the symphysis, and with admixture of tendon and flesh is inserted upon the tibial trochanter and linea aspera as far as the mid-shaft of the femur. The *Pectineus*[3] (*Pe.*) much shorter than the preceding, comes from the lower pelvic brim, symphysis to acetabulum, and goes to the trochanteric fossa.

The *Biceps femoris*[4] is extraordinarily developed and is triple-headed; one (*B. f.*^{1}), the longest, arising from the spines of three anterior caudal vertebræ, and descending to the tuberosity of the ischium, it receives a fresh insertion, while the main belly of this enormous mass proceeds over the head of the tibia, where it is inserted along with the other bellies by a short broad tendon, in front of the head of tibia and patella. Another portion (*B.f.*^{2}) arises separately from the front of the ischial tuberosity by a broadish tendon, which forms a tolerably large belly, at first in union with the next, but lower down separated slightly and widening out on the side of the leg, joins the 1st insertion into the head of the tibia, while part becomes strongly tendinous or aponeurotic and runs down the side of the leg. The third division (*B.f.*^{3}) seems a continuation of the first, or may be said to be derived from the tuberosity of ischium; it joins in a flattened muscular expanse the belly of the second one. It furthermore sends another tendon of fascia down the leg, which forms a continuation of the tendo achillis below. This latter tendon (*B.f.*^{3} fig. 12) is the deepest of the tendons composing the tendo achillis, and is joined by the flattened fascia tendon of the soleus, the two afterwards increasing considerably in breadth and thickness, and ultimately splits (vide ** fig. 12), a portion going to either side of the os-calcis.

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[1] P, 4e *Extensum Ilio-rotulien.*

[2] Short and middle adductors are alone mentioned in the Explanation of Cuvier's plates, l, l^1, Pl. 323, fig. 1, *sous-pubo* and *sous pubifemorien.* They do not agree in appearance with what I have found obtain in *P. sumatrensis.*

[3] Portion of *des Pubo-fémoriens, κ.*

[4] q *Ischio-péronien*, q′ *sa portion fémorale*, + q *accessoir coccygien.*

The *Semimembranosus*[1] is of most extraordinary bulk (*Sm.*), the muscular mass being several inches in thickness. It is double-headed, or at least has different parts of origin, which however run into one another from the vast size of the fleshy mass. The main origin, in so far as action upon the limb is concerned, is that from the whole length of the border of horizontal ramus of pubis and ischium, and from part of the outer side of same. The secondary origin is by a flattened sheet of coarser fibres from the dorsal surface, and outer side of the caudal vertebræ from opposite the ischium, half-way along to the tip of tail. The single belly of these two origins crosses downwards and towards the knee, and terminates in a triple insertion, the most superficial one by a broad fascia into the inner capsule of the knee-joint, below the patella. Another, the most delicate and lowest, by a small long round cord-like tendon, which comes out of the deep belly of the muscle and is implanted in the surface of the inner tuberosity of the tibia, dipping somewhat beneath the internal lateral ligament. The last and strongest insertion is placed deeper, and is inserted by a broad short tendon into the inner condyle of the femur. Its bulk must give great power of flexion and rotation inwards of the limb, the caudal portion also adding to the length, and altering the direction of the leverage, whilst the latter part may be the reason why the tail assumes the odd dependent position observed in the living animal. With a double origin like the last, but not by any means so thick, the *semitendinosus* (*St.*) springs from the outer surface and tuberosity of ischium, and by a thin narrow band from the caudal vertebra, between the biceps and semimembranosus[2]. These ultimately form a long rounded belly terminating in a short broad aponeurotic tendon, implanted into the shaft of tibia its middle and inner side.

The *Gastrocnemius*[3] (*Ga.*), with the usual condyloid origins, forms a fleshy calf; a median sulcus almost dividing it into two separate halves. These terminate about the middle of the leg, in a strong body of tendon, which, with a slight separation of fascia, resolves itself into two. The inner one crosses superficially to the outer side, but can hardly be separated from the other, as they together are inserted into the os-calcis. This manner of crossing of these tendons, as well as a similar crossing of that of the plantaris and soleus, besides giving superadded power of flexion, must also steady the elevating motion of the foot, and slightly through the toe-end of the lever, outwards or inwards, according to circumstances.

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[1] *Ischio-sous-tibien*, s. and accessoir + s.

[2] *Ischio-prétibien*, r.

[3] The muscle answering this in the "Myologie" is indicated as *portion du Bi-fémoro-calcanien*, and lettered *a'*.

From its diminutive size and altogether aborted appearance, the Soleus[1] (*So.*) is still more remarkable. It is little more than a mere cord which arises from the inner side of the last on the external posterior surface of external condyle. Proceeding down the leg parallel with it, and nearly lying beneath, it terminates at the lower third in the strong flat tendon common to it and biceps which is inserted into the os-calcis, the deepest of the tendons of tendo achillis. It moreover sends a small slip of tendon to the tendon of the gastrocnemius, and there is an attachment with the accessory slip of Plantaris, as already described. This muscle has almost no belly, but is chiefly composed of tendon its whole length, a few muscular fibres being seen only at its commencement. Turner[2] remarks, "the soleus is wanting, and the tibialis posticus is wanting also."

The *Plantaris*[3] (*Pla.*) is peculiar in being a long cordiform muscle, which arises from the external condyle at its highest part. Traversing between the condyles in the popliteal space, it descends the leg near the middle line, and about halfway becomes entirely tendinous, and spreading out over the surface of the os-calcis, partly attached to either side, it continues into the sole of the foot, where it joins the plantar fascia lying superficially and strongly adherent to it. At the proximal end of the metatarsals it divides into three strong perforate tendons supplying the three toes present. In the back of the leg, below the middle, there is an accessory small slip of fascia-like tendon which diverges inwards, joining a slip from the soleus, and terminates in a long compound tendon of biceps, soleus and gastrocnemeus.

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[1] Neither figured nor indicated in the *Recueil.*

[2] *P. Z. S.* 1850, p. 106.

[3] Not distinctly recognisable in Cuvier's drawings, although in the explanation of Plates the letter γ is applied to what is supposed to be the *Plantaire grêle* (*Fémori-calcanien*).

Of moderate bulk the *Tibialis anticus* (*Ta.*) has a double head of origin[1]. The main inner one from the upper third of the tibia's outer surface and the interosseous membrane. The second by aponeurotic sheet from the external femoral condyle and from the extensor longus digitorum; it joins the first at middle of ulna. Joint insertion, the proximal end of the inner dorsal surface of the second metatarsal bone.

The *Extensor longus digitorum*[2] (*E. l. d.*) arises by a single head from the middle and inferior surface of the outer condyle. Although medium sized in belly, its fleshy fibres reach the ankle-joint before forming a thickish tendon. This at the middle of the metatarsals divides into three, respectively supplying the digits (viz. 2nd, 3rd and 4th); the middle one is much the broadest.

The representative of the *Extensor longus pollicis*[3] (*E. l. p.*) is a small slip of fibre given off superficially from the extensor longus digitorum about the lower fourth. This runs parallel to, or rather to the inner surface, ends over the proximal end of the ex. brevis dig.; but its tendon, moreover, goes backwards and outwards beneath the tibia before it is inserted into the foot.

Although seemingly a single muscle[4] the *Extensor brevis digitorum* (*E. b. d.*) can be divided into three thin bellies, united, however, towards the toes. Origin, the os-calcis the ankle ligament and bones beneath. Insertion, proximal phalanx of middle toe, by a very broad aponeurotic tendon. At this point a small tendo-fascial slip goes separately to the inner sides of the outer toes.

A single Peroneus, the *P. longus* (*P. l.*), is all that obtains in the limb of the Sumatran Tapir. It is not large. Origin, upper three-fourths of the fibula: the tendon thence curves round the styloid process, and, passing along the side of the foot, is inserted into the external face of the proximal end of the proximal phalanx of the outer digit. My note, made whilst engaged in the dissection, runs: No other peronei present;

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[1] *Tibio-sus-tarsien*, δ.

[2] *Périnéo-sus-onguien*, ζ, fig. 1, Pl. 322.

[3] *Péronéi-sus-onguien*, ζ^1, poorly represented by Cuvier.

[4] The *Calcanéo-sus-onguien*, fig. 1, Pl. 322 ζ.

nevertheless I find in Fig. 1, Pl. 322, of Cuvier's own sketch of *T. Americanus*, an indistinct recognition of double peronei opposite the hock. They are lettered as *Peronei-sous-tarsien* ϵ, and *Peronei-sus-metatarsien* ϵ^2.

The *Flexor longus digitorum*[1] (*F. l. d.*) arises from the upper three-fourths of the shaft and head of fibula and from the interosseous membrane; its muscular belly, however, reaches to the os-calcis, and covers the whole of fibula. It there forms a strong tendon behind the os-calcis, which winds round to the inner side and forms the very strong thick flattened tendon and sole. This is joined by the flex. long. hallucis, opposite the proximal end of the metatarsal, and the two unitedly passing forward about two inches, again subdivide into the three very strong thick and broad perforating tendons of the digits, which as usual proceed to the proximal ends of last phalanges, spreading out thinly the entire breadth of the bones.

The *Flexor longus hallucis*[2] (*F. l. d.*) arises by flattened tendinous fascia from the (*posterior* tuberosity) styloid process of head of fibula, deeper and within, but in union with the flexor longus digitorum. It forms a moderate sized belly which crosses inwards about middle of tibia, and ends in a strong narrow round tendon above the malleolus. This glides in the groove behind the malleolus of tibia and crosses again somewhat outwards in a similar shallow groove, joining the broad plantar tendon of the flex. long. dig. at the proximal end of metatarsal. Of *Tapir Americanus* Turner (*l. c.* p. 106) says: "The flexor longus pollicis is here, as in all the lower animals, the principal flexor of the toes"—a remark not quite appropriate to the Sumatran species.

As in the fore-limb there are three *lumbricales*[3] in the hind foot, the outer being much the largest. This last (L^1, Fig. 12) arises between the two outer tendons considerably behind the middle one. It has a large belly, which opposite the distal end of the metatarsal divides; and from the muscular fascia of each a tendon is derived, the outer one going to the inner side of the outermost toe, where it is inserted into the distal end of the second phalanx—the inner one gives a similar tendon to the outer side of the middle toe. The middle lumbricalis (L^2) comes from the fork between the second inner deep tendons, but chiefly from the middle one, going somewhat round its back or deep surface. It is inserted by a small flat tendon into the inner side of the proximal end of the proximal phalanx of the middle (or 3rd) digit. The innermost lumbricalis (L^3) springs from the inner margin of the inner deep tendon, and is in part attached to the inner perforatus tendon of the same digit. It sends a delicate tendon of insertion into the inner side of the proximal end of the proximal phalanx of the inner (or 2nd) digit.

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[1] *Tibio-sous-onguien*, fig. 1, Pl. 323, ι.

[2] *Tarso-phalangien* ι^1, fig. 1, Pl. 323.

[3] Not noticed by the observers quoted.

The muscular fibres of the *popliteus* (Po, Po^*) are very considerable; including the head of the bone, they extend down the posterior surface of the tibia to the middle of its shaft. Its length probably helps flexion as well as the usual rotation of the leg. I did not recognise a *Tibialis posticus*, agreeing thus with Turner's observation in the American Tapir and the drawings in the *Recueil.*

The *Interossei*[1] of the hind-foot are uncommonly like those of the fore-foot, both in disposition and general development. There are three pairs of double ones (I^1, I^2, I^3), attached to the metatarsal bones nearly their whole length. The origin of each pair is single, terminating in two tendons inserted into each side of the proximal end of the proximal phalanges. The middle are placed deepest. Besides these double muscles there are two single ones, smaller in size and placed superficially to the median double one, but somewhat overhung by the two lateral double ones. The most external (Si^1) arises between the inside of the outer double one and inner side of middle one. Insertion by a tendon to the inner side of outer digit, and into proximal phalanx, but to the dorsal surface of outer double muscle. The internal single one (Si^2) is attached in a similar manner outside its inner double muscle.

5. *Results of the Present Observations.*

Modern comparative anatomy is suggestive of the fine arts. Some revel in creations of their own—airy, fantastic, but always enticing, as is painting and poetry. Others play the part of the sculptor, and by dint of chisel work out the graces of nature her-self. It has been shown that although the Tapir is wanting in the great skin-folds of the Rhinoceros, its hide, nevertheless, presents similitude in relative thickening at the same points.

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[1] Not hitherto commented on.

As regards proboscis, it is intermediate between *Elephas* and *Rhinoceros*, shape allying it with the first, dimension and amount of prehensility nearing it to the second. With *Equus* it agrees in the elongate special levator muscle of the upper lip, while from *Sus* there is a marked separation in there being no terminal cartilaginous disk. The curious nasal sacs more than remind one of the somewhat proboscidean-like *Saiga* amongst the ruminants, and this sacculate interior nares carries us to the Cetacea. The stomach, gut, and cæcum present those curious gradations of structure, leaning to the Ruminantia, by tendency to gastric complication, but with stronger characteristics shade to its nearer allies among the Perissodactyla. But even among the Tapirs themselves shades of division obtain. These lead me to suspect that in the visceral organs, as in the skeleton, the departures from uniformity show connecting links with bygone fossil families. For instance, in the visceral organs of the ancient Paleotherium and Hipparion, doubtless intermediance of structure existed which would fill up blanks in the living Perissodactyle group, as indeed the fossil bones afford evidence.

Among the myological features of interest, as compared with allied forms, may be noted: the restricted area of the panniculus; the multiple division of the biceps femoris and gracilis, and the very low insertion of portions of them; the tendinous nature of the plantaris and soleus, their intricate lower divisions and combination with gracilis, &c.; the very full development of interossei and lumbricales; the single peroneus; the splitting up of the outer long digital extensors of the fore-limb; the presence of flexor brevis manus, abductor minimi digiti and pronator quadratus; a belly representing flexor brevis pollicis, and the extra division of triceps; the multiplicity of the sterno-mastoid; and the considerable coalescence, fleshy structure and elongation of the naso-labial muscles into a proboscis, besides other peculiarities embodied in the text. Some of these variations both agree and differ with the four-toed Hippopotamus, others again assimilate and recede from the differently toed families Suidæ and Equidæ. Characteristic and appreciable changes ensue in the fleshy legs and well-padded foot of the Elephant; but, as my paper has already assumed goodly proportion, I defer a full comparison of our family with others of the orders Perissodactyla, Proboscidea and sub-order non-Ruminantia, till a favourable opportunity.

DESCRIPTION OF THE PLATES.

PLATE VIII.

Fig. 1. Side Aspect of the Malayan Tapir in the attitude of walking, to show in one view the superficial layer of muscles. Drawn from the dissection and reduced.

Pc^1, Pc^2, and Pc^3. Panniculus carnosus, its several portions as described.
L. l. s. a. n. Levator labii superioris alaque nasi.
Py. Pyramidalis nasi.
L. s. p. and *L. a. o.* Levator superioris proprinas and L. anguli oris.
O. o. Orbicularis oris.
Z. Zygomaticus.
Bu. Buccinator.
Ma. Massetor
Sp. Splenius.
Tz. Trapezius.
S. l. Sacro-lumbalis.
Lo. d. Longissimus dorsi.
S. p. p. Senatus posticus posterior.
La. d. Latissimus dorsi.
Ch. Cephalo-humeral.
St. m. Sterno-mastoid.
B. a. Brachialis anticus.
D. Deltoid.
T. Triceps and conjoined Dorsi-epitrochlear.
E. c. r. l. and *b.* Extensor carpi radialis longior and brevior.
E. o. m. p. Ext. ossis metacarpis pollicis.
E. c. d. Ext. communis digitorum.
E. me. d. Ext. medii digiti.
E. m. d. Ext. minimi digiti.
E. c. u. Ext. carpi ulnaris.
Pa. l. Palmaris longus.
F. s. and *p.* Flexor sublimus and profundus.
G. mx. and *G. md.* Glutei maximus and G. medius.
T. v. f. Tensor vaginæ femoris.
Bf^1, Bf^2, Bf^3. Biceps femoris, its three divisions.
S. m. Semimembranosus.
T. a. Tibialis anticus.
E. l. d. Extensor longus digitorum.
P. l. Peroneus longus.
*Retinaculum ankle-joint.
Ga. Gastrocnemius.
E. b. d. Extensor brevis digitorum.
Fl. h. Flexor longus hallucis.

Plate IX.

Different views displaying the myology of the fore-limb; the Liver and the front foot.

Fig. 2. Inner muscles of the entire left fore-leg.

Fig. 3. Semirotate or ¾ view of the outer or extensor tendons and muscles of the lower segment of the fore-leg.

Fig. 4. Distribution of the flexor muscles of the same segment.

Fig. 5. The Interossei, &c., of the left fore-foot.

The lettering of these four figures partly agrees the one with the other and with fig. 1.

S. mg. Serratus magnus (portion of).
S. Subscapularis.
S. sp. Supra spinatus.
St. s. Sterno-scapular.
C. h. Cephalo-humeral.
C. b. Coraco-brachialis.
B. Biceps.
B. a. Brachialis anticus.
T. ma. Teres major.
D. ep. Dorsi Epitrochlear.
T^1, T^2, T^3. Triceps, its three heads.
S. l. Supinator longus and
E. c. r. l. and *b.* Extensor carpi radialis longior and brevior.
P. r. t. Pronator radii teres.
Pa. l. Palmaris longus.
F. c. r. Flexor carpi radialis.
F. c. u. Flex. carp. ulnaris.
F. s. and *p.* Flex. sublimus and profundus.
F. b. m. Flexor brevis manus.
E. o. m. p. Extensor ossis metacarpi pollicis.
E. c. d. Extensor communis digitorum.
E. me. d. Ext. medii digiti.
E. m. d. Ext. minimi digiti.
} 1, 2, 3, 4, 5, elementary constituents.
E. c. u. Ext. carpi ulnaris.
F. s. d. Flexor sublimus digitorum.
F. p. d. Flex. profundus digitorum.
F. l. p. Flexor longus pollicis.
L. Lumbricales.
Ab. m. d. Abductor minimi digiti.
Si^1. Si^2. Si^3. Superior single interossei (three in all).
I^1, I^2, I^3, I^4. Deep double interossei.

Fig. 6. Sole of the right fore-foot. *p.* Pad and I. II. III. IV. digits respectively.

Fig. 7. The Liver, its posterior or lower surface,
r. right and *l.* left lobe. *cy.* Cystic, *q.* Quadrate, and *sp.* Spigelean lobes. *cl.* Coronary ligament. *vc.* Vena cava.

Plate X.

Dissections of the hind-leg and of the proboscis.

Fig. 8. Upper view of a fore segment of the face to display the nasal canals and sacs. The canals are partially opened; the left eye has been scooped out and muscular layer removed on same side.

N. Nasal bones. *nf.* Naso frontal sacs, the arrows pointing the course of the canals towards the anterior nares. *e.* Situation of right eye, and *o.* of left orbit. *c.* mandibular condyle. *L. l. s. a. n.* Levator labii superioris alaque nasi.

Fig. 9. Sketch of a dissection of the anterior nasal passages, separated from the skull and seen partially from behind but on the right side. The left canal and sac are opened, the narial septum being sliced transversely and vertically.

an. Anterior nares. *W. W.** left and right external walls dragged out. *sp.* septal cartilage. *nf.* Left naso-frontal sac. *f* + *m.* Sinus representing either the facial branch of last or maxillary pouch. Arrows lead forwards.

Fig. 10. Sole of right hind-foot, II. III. IV., the digits.

Fig. 11. Superficial inner view of the entire left hind-leg.

Fig. 12. A deeper view of the groin, &c., same side.

Fig. 13. Muscles and tendinous distribution of the lower moiety of the left hind-limb, seen down-stretched, and from behind.

Fig. 14. Plantar surface of left hind-foot displaying the interrossei.

Figures 11 to 14 are lettered as under:—

R. f.	Rectus femoris.
Sa.	Sartorius.
Pe.	Pectineus.
Ve. and *Vi.*	Vastus externus and internus.
Ad. m.	Adductor magnus.
Ad. b.	Adductor brevis.
Ad..	Gracilis.
Sm.	Semimembranosus.
S. t.	Semitendinosus.
T. a.	Tibialis anticus.
E. l. d.	Extensor longus digitorum.
E. b. d.	Ex. brevis digitorum.
Ga.	Gastrocnemius.
Bf^3.	Biceps femoris 3d part insertion.
B. f. 3*.	Tendon sent off to join soleus, &c.
Pla.	Plantaris.
So. *So.**	Soleus with tendinous slip joining gastrocnemius, and ** its main terminal division.
Po. *Po.**	Popliteus.
P. l.	Poroneus longus.
F. l. d.	Flexor longus digitorum.
L^1, L^2, L^3.	Lumbricales.
Si^1, Si^2.	Single superficial interossei.
I^1, I^2, I^3.	Deep double interossei.

ON THE STERNUM AND VISCERA OF PELL'S OWL, *Scotopelia peli*, Temm. BY JAMES MURIE, M.D., F.L.S., F.G.S., &c.; *Lecturer on Comparative Anatomy at the Middlesex Hospital, and late Prosector to the Zoological Society, London.* (Pl. XI.)

Of the Sternum and Shoulder-Girdle.

THE reduced views, about two-thirds their natural dimensions, which I give of this osteological region, figs. 5 and 6, visually express the characters imprinted in the species. As the specimen, however, is of so rare a kind I may describe it in detail, to complete its scientific register.

The extreme length of the sternum from the rostrum to the middle xiphoid process is two inches and eight-tenths. The greatest breadth is one and nine-tenths of an inch. The perpendicular height, taken in a line stretching from the tip of the costal process to the fore part of the keel, gives one-tenth less than the above breadth. The keel from end to end, measured in a straight line, is equivalent to about 2·4 inches.

Speaking in a general way the breast-bone is moderately strong, but not nearly so powerfully built as in the Falconidæ. The keel is fair sized and forms a long, regular, curvilinear sweep from before backwards and upwards. Its anterior vertical margin possesses a large and deepish bayed notch, surmounted by a well defined downwardly set rostrum (*r.*), and inferiorly limited by a short obtuse prow-like projection. The under surface of the sternum as a whole is quadrangular, a third longer than broad; the fore end has a widish, somewhat chevron contour, the hinder end, excluding the processes, is more rounded. The lateral edges, nearly parallel, bulge a trifle outwards near the posterior end. Each pectoral plate, lophosteon and pleurosteon of Parker[1], has a moderate tilt towards the costæ. The ridge which bounds the mid-pectoral muscle is short and sharply defined; the interspace between it and the ribs being of medium relative breadth, but of fair depth and height. Development of costal process (*c. p.*) is considerable, and it pouts well up. Articulations for five sternal ribs exist, which latter are long, particularly the hinder ones. There are four xiphoid notches, the inner pair shallow but wide, the outer pair narrower and deeper. The external xiphoid bar (*e.x.*) is about three quarters of an inch long, middling narrow, and tapers to its free end: the internal xiphoid process, also bluntly acuminate, barely exceeds 0·2 inch, and does not extend quite so far backwards as the middle xiphoid (*m. x.*): the latter is rounded, the keel terminating in a slightly expanded triangular flattened surface.

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[1] I use freely the ready-coined anatomical terms of my friend, whose laborious researches (Ray Soc. Monograph, 1868) are a fund of study connected with the vertebrate, shoulder-girdle and sternum.

The coracoids (*cr.*) throughout are uncommonly stout and with great breadth of epicoracoid (*e. cr.*), slight scooping of the angle of which produce a slight ridge upwards on the shaft of the bone: the coracoid grooves do not quite meet. The scapular end of the coracoid is full and massive.

Furcula or combined clavicles (*cl.*) subtend and meet with the outline of a gothic arch; each præcoracoid segment (*pcr.*) is considerably trifacially enlarged and strong; from this gradually and steadily decreasing almost to a fine spicular rod towards the sternal angle, where they join with slight increment, but no discernible interclavicle piece[1].

As regards the scapula, its length is about three inches with strength in correspondence, the blade being sabre-shaped. The glenoideum is large and the acromion, I believe, fair-sized. Upon the latter point I express myself reservedly, my note thereupon being obscurely worded and my original drawing not supplying the deficiency.

The Viscera.

What remained of the gullet (1¾ inch) was thin-walled and nearly uniform in calibre, the muscular fibre being in a diaphanous sheet. Some of the longitudinal mucous rugæ are well marked below; they are less persistent above, owing to the dilatability of the tube. Superiorly and within, the uncommonly thick glandular wall of the proventriculus ceases abruptly with a mitral outline: inferiorly the border is more circular. The interior arrangement of the glands is such, that the mucous surface to the eye resembles a madrepore coral, being studded with minute oscula and puckered divisional radii. Proventricular length 1¼ inch. In the contracted condition the gizzard exteriorly is subcircular, 1¼ inch in diameter, and with a central tendon as big as a shilling in circumference. Muscular coat is evenly distributed and relatively thick: the mucous coat possesses complicate folds and a tough epitheleal lining. The small gut measures 30, the great gut 2¼ inches, or the entire intestinal canal is = 32½ inches. The lower bowel, as likewise several inches of the duodenal loop wherein lays the pancreas, are wider, but the average diameter runs about 0·2 inch. Cæcal appendages subequal, each about 2·2 inches in length and pyriform with moderate dilatation.

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[1] In the lithograph the artist has hardly given tenuity enough in proportion to the lower moiety of the clavicle, this being most markedly apparent in the bones themselves.

As in most avine forms the liver is bilobed; these, subequal in size, are connected only by a narrow hepatic bridge. But the right moiety has a tendency to subsidiary lobulation, inasmuch as its lower or posterior end, that whereon the gall-bladder lies, is smaller and more rounded than the upper or anterior portion; and it is partially marked off from the latter by a shallow furrow, both ventrally and dorsally. The liver is rather over two inches in length, and each half rather under an inch and a half in transverse diameter or breadth. The inferior vena cava enters the hindermost corner of the right lobe. The gall-bladder is egg-shaped, 0·9 by 0·6 in diameter. The bile-duct leaves at the post-inferior end.

All that I obtained of the respiratory apparatus was the lower portion of the larynx, the bronchii, and the imperfect lungs, as depicted in Fig. 3. The latter has the usual spongy texture of birds, and, as far as I could make out, are short. The vascular channels are large, from which one would infer vigorous circulation. One pair of broncho-trachealis (*B. t.*) and one pair of sterno-trachealis (*S. t.*) obtain: the former widish. The tracheal rings, at least the lower ones, without being bony are uncommonly rigid; their breadth equals the cellular interspace, and both are narrow. Each cartilage completes a circle, being ever so little narrower at the middle, in front and behind. The lower larynx or syrinx (*la.*) has moderate dilatation, and is composed of 3 or 4 whole and as many half rings. The antero-posterior inner septal division is stoutish and does not rise high. The lowermost half ring is much more supple and elastic than those above, and it intrudes towards the interior of the cavity so as to become valvular in position, and doubtless acts as such in vocalization. Semilunar bronchial cartilages, 15 in all, are feeble and only half the width of the transparent interstitial membrane.

No special features were detected by me in the heart, which after being immersed in spirit, shewed great thickness of the left ventricular wall and peculiar longitudinal striations in the interior of the aortic arch.

Each kidney is imperfectly trilobed, the anterior one (*a*) being large, thick and uniform: the middle (*m*) and the posterior (*p*) lobules being individually and unitedly very much smaller, flatter, and together forming a kind of tailed appendage to the former. The ovarium (*o*) exhibited no enlargement, being altogether a trifle over 1 inch long; the ova ranged from a pin's head to a small bead in size. The convoluted left oviduct was developed as usual.

Relationship of Scotopelia among the Strigidæ.—The very remarkable West African form, Pell's Owl, was first referred to by Temminck[1] under *Strix peli.* Bonaparte in his "Conspectus[2]," places it after *Athene*, &c., and between *Ciccaba* and *Ketupa*, as a genus by itself, *Scotopelia.* His generic name has in general been adopted by succeeding writers: though Prof. Kaup, a long while ago[3], gave grounds for classing it under *Ketupa*[4]. The same author likewise arranged it[5] under the genus *Bubo* of Cuv., with the following as subgenera, viz. *Lophostrix*, *Bubo* (Kp.), *Ketupa*, *Urrura* and *Pseudotynx.* These latter legitimately true genera of other authors, but, as he emphatically remarks, "this is a very grave fault."

Hartlaub[6] has published by far the most explicit description of *Scotopelia peli.* A specimen is recorded in Duchaillu's collection and commented on by Cassim[7]. Lastly, a most excellent figure of the bird, from a living specimen, which was exhibited[1] in the Regent's Park Gardens, has been given by Mr John Henry Gurney in the *Ibis*, 1859, Pl. xv. p. 445; and there he notices some slight differences from Bonaparte's definition of the species, as well as calls attention to its geographical distribution.

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[1] *Mus. Lugd.*

[2] *Generum Avium*, p. 44.

[3] Jardine's *Contrib.*, 1852, p. 117. A quotation I make second-handed, not having been fortunate to obtain the Vol. in question.

[4] In George Gray's recent *Hand-List of Birds*, Pt. I, *Scotopelia* forms a subgenus under *Ketupa* followed by *Scops*, &c.

[5] *Monog. of the Strigidæ*, *Trans. Zool. Soc.* IV. 237.

[6] *Syst. der Ornith.* West Africa's, and Cabinis *Jour. f. Ornith.* III. 358.

[7] *Jour. Acad. Nat. Sci. Philadelphia*, 1859, p. 52.

All the preceding authors have formed their judgment on the bird solely by its outward characters. I had the opportunity of a hasty glance of the sternum and the viscera of the last-mentioned specimen, prior to the skin being mounted and transmitted to the Norwich Museum. Even with this limited anatomical material some additional notion of the bird's affinities are gained.

As regard the *tout ensemble* of the breast bones, the full-sized coracoid and scapula, inferiorly tenuous furcula, and but moderately strong sternum, belong, undoubtedly, to the characters of the Strigidæ and not the Falconidæ. In the shoulder-girdle of all the owls' skeletons I have examined, the lower two-thirds of the clavicle tapers very considerably to join its fellow without intervention of hypocleidium; but Nitzsch[2] states that in *Nyctale*, and Parker[3] in *Athene noctua*, the clavicles do not meet. In this circumstance *Scotopelia* agrees with the group and not with the above two forms. The enlargement and three-sided condition of each coracoid end of the furcula, and widening of epicoracoids, though differing in minor detail from certain of the Strigine group, do not afford very presumptive evidence of affiliation. The sternum yields appreciable characters. In *Strix* the rostrum is either abortive or absent, the anterior portion of keel is barely produced forwards, the middle and internal xiphoid processes are more or less fused together, and the external xiphoid spaces and processes relatively very short: points trenchantly separating the genus from *Scotopelia*. Both in *Otus*, *Brachyotus* and *Syrnium*, rostrum is wanting or very small, the front edge of the keel is not emarginate as in Pell's owl, being rather straight and perpendicular, with a slight modification in *Sy. nebulosum* and *O. vulgaris*: the outer and inner xiphoids are slender, terminate subequally and relatively long. *Nyctale* and *Noctua* also differentiate themselves from our specimen in the internal xiphoid bar, being produced considerably beyond the external one. In several sterna of *Athene* examined by me, the rostrum was diminutive, in others it was more developed, but in these, unlike *S. peli*, the fore edge of the keel was straight and vertical, whilst the outer xiphoid is slender and elongate, and the middle xiphoid short and narrow. *Nyctea* (*N. nivea*) with regard to the shape and development of its processes bears some resemblance to *Scotopelia*, but Eyton's[4] plate alone furnishes me data to judge of the posterior end of the sternum. In *Bubo* there is a well pronounced rostrum, but this is carried nearly straight forwards, and there is no anterior emargination of keel; the external but slightly surpasses the internal xiphoid, and the middle xiphoid is square rather than ovate. In *Ketupa flavipes* there is a tendency to depression of the prominent rostrum, but no inferior emargination, the xiphoids moreover are subequal, the middle truncate. The latter character applies to *K. javanensis* as Eyton has figured[1].

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[1] From April 1866 to Oct. 1867.

[2] Quoted by Kaup, *monog.* p. 206.

[3] *Ray Soc.* 1868, p. 168.

[4] *Osteologia avium*, Pl. IV. fig. 2.

Excepting it may be in the length of the alimentary canal and cæcal tubes, the viscera cannot be relied on to determined alliance. Their structure in *Scotopelia* is precisely like the other owls, crop being wanting, and therein they differ from the Falconidæ save *Nauclerus furcatus*.

It results on osteological grounds, that Pell's owl comes nearest *Ketupa* and *Bubo*, though precisely corresponding to neither. If *Ketupa* is only worthy of subgeneric distinction, as Kaup affirms[2], then *Scotopelia* likewise must fall under the same ban, but not a species of that form. If ornithological genera, however, are ruled by anatomical structure, Pell's owl and its nearest ally must rank as coequal with *Bubo*. Notwithstanding, I am satisfied that until a far more searching scrutiny and analysis of the Strigine osteology is worked out, the respective value of the groups, genera and subgenera is but provisional.

DESCRIPTION OF PLATE XI.

Fig. 1. Renal and reproductive organs of the female Pell's owl, from their ventral aspect ⅔ nat. size. *a.* Anterior, *m.* middle and *p.* posterior lobes of right kidney. *o.* Ovarium, *o. d.* ovarian duct. *ar.* artery and vein.

Fig. 2. The stomach and lower end of œsophagus opened from the left side ⅔ nat. size. *pr.* proventriculus, *gz.* gizzard. *py.* pyloric orifice.

Fig. 3. The lower larynx, &c. from in front, of natural dimensions. *st.* Sterno-trachealis muscle of the right side. *bt.* Broncho-trachealis. *la.* Lower larynx. *b.* Right bronchus. *l.* Portion lung of same side.

Fig. 4. The alimentary canal from the middle of the œsophagus to the vent, considerably reduced. *oe.* œsophagus. *t.* tendon of gizzard. *cæ.* Cæcal appendages. *sp.* Spleen. *pa.* Pancreas. *r.* Rectum.

Fig. 5. The Sternum and shoulder-girdle, seen from below. Lettering as under.

Fig. 6. Lateral view of the same. This and above about ⅔ nat. size. *sc.* scapula. *cr.* coracoid. *ecr.* epicoracoid. *cp.* costal process. *r.* rostrum. *cl.* clavicle. *pcr.* præcoracoid. *k.* keel. *ex.* external, *in.* internal, and *mx.* middle xiphoid process. *sr.* sternal ribs.

[1] *Op. cit.* fig. 8.

[2] See his final remarks in *monog.* quoted p. 259.

ON THE MUSCLES AND NERVES OF A CHIMPANZEE (TROGLODYTES NIGER) AND A CYNOCEPHALUS ANUBIS. By Frank Champneys, B.A., Brasenose College, Oxford.

Professor Rolleston having kindly provided me with a young Cynocephalus Anubis, and subsequently with a female Chimpanzee, I have dissected the greater part of the muscles and nerves of those animals. I have substituted, on the advice of Prof. Rolleston, for the name Magot that of Inuus nemestrinus; for this, he informs me, was the correct name of the animal from which Dr Church drew his observations. My best thanks are due to Prof. Rolleston for assisting me with his valuable advice. I feel also bound to acknowledge, as his private property, the ligamentous representative of the long coracoid in the Chimp.

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Vertebral formula in Chimp. C_7, D_{13}, L_4, $SC._9$ (usually 5 sacral). Dr Embleton found 10 sacro-coccygeal vertebræ.

The terms "hand" and "foot" have been used as more convenient than "fore-hand" and "hind-hand."

The creature had been skinned, to the destruction of nearly all the cutaneous nerves.

The An. was quite young. Its body was covered with tawny hair, on the back it was 2¼ or 3 inches long, and darker than the rest; on the pectoral region it was nearly or quite absent. On the face it was scattered, and there were dark bristles on the muzzle and chin. The length of the tail was equal to that of the trunk, the proximal half hairy, the distal half bare.

Muscles.

The *Platysma myoides* in the Chimp. was largely developed. It rose from the superficial fascia along a line extending along the external half of the external and superior edge of the trapezius. The fibres ran straight and parallel to be inserted into the anterior part of the zygomatic arch, the angle of the mouth and the mental symphysis, becoming continuous with the muscles and fascia in those regions.

An inch from the symphysis the fibres of the left side overlapped those of the right. Quain says that when in man there is a decussation of fibres those of the right side overlap those of the left. In AN. it lay between the two layers of superficial fascia, and arose by thin, almost parallel, bands over the region of the Trapezius, Deltoid, and upper part of the great Pectoral; ran on each side upwards and mesiad, over the clavicle, and over the ramus of the jaw to the symphysis, over which the two sides decussated. A few fibres passed over the lower and inner part of the exterior wall of the cheek-pouch, and lost themselves in the superficial fascia covering it[1].

Dermo-humérien (Cuv.), absent in CHIMP., was in AN. in close connection with the skin of the sides and back from the pelvis to the axilla, and was coextensive with the Latissimus dorsi, which it covered. It was also continued, though with scanty fasciculi, over the outer side of the thigh as far as the knee. Its ventral edge was the most muscular, from which it gradually became less muscular and more tendinous as it stretched dorsa, losing all its muscular fibres opposite the middle line of the back. In the axillary region its muscular fibres were also few, and in some parts absent; it gave a few fibres to the Lat. d. after having previously received a few from it. It continued to ascend, and this with greatly increased muscularity, till it was again gathered up and terminated by a tendon, which was inserted, together with that of the great Pectoral, below the head of the Humerus.

The connection mentioned above seems to be represented occasionally (Henle and Wood) in man by a connection between Latissimus dorsi and Pectoralis major; and in the Pigeon by a slip described and figured by Rolleston (Pl. 2).

Orbicularis oris in CHIMP. was mutilated.

Levator labii superioris, *Levator anguli oris* present, but not well differentiated.

Depressor labii inferioris not distinguishable.

Zygomatici were represented by one muscle, half-inch wide, which rose from the anterior half of the zygomatic arch, and from the temporal fascia above it. Over its most anterior origin a second strip rose from the temporal fascia, but fused with the rest of the muscle half an inch below the zygoma.

Sterno-cleido-mastoid in CHIMP. had a double origin from the sternum[2]. The clavicular tendon, broader than the sternal though narrow, arose from the sternal end of the clavicle[3].

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[1] Cuvier says: "Dans le magot et les cynocéphales, il enveloppe l'épaule et s'étend en haut ou en arrière du cou beaucoup plus que dans l'homme."

[2] This double sternal insertion is not found in Man, nor does Vrolik mention it in the Chimp., though he does (p. 25) remark it in the oran-outan. Cuvier says nothing about it.

[3] Macalister, Wilder, and Wyman, also found the sternal part larger than the clavicular part. Duvernoy, in the Gorilla, found the reverse proportion. The

Acromio-basilar (Vicq. d'Azyr.) or Acromio-trachélien (Cuvier) rose in the CHIMP. from the occipital bone on a line with the occipital condyles[1], and was inserted into the acromial or external half of the clavicle anteriorly to the insertion of the trapezius. In AN. it was inserted into the exterior third of the clavicle, and rose from the ant. side of the transv. pr. of the altas, and by a tendinous slip from the occipital.

Trapezius in CHIMP. was as in man.

Omo-hyoid in CHIMP. was as in man[2].

Sterno-hyoid in CHIMP. was as in man, and marked nearly in the middle with a tendinous portion, as Macalister found it.

Sterno-thyroid in CHIMP. was as in man[3].

Thyro-hyoid in CHIMP. was as in man, the anterior or internal fibres of the sterno-thyroid being continued into it.

Great Pectoral in CHIMP. rose from the anterior or internal half of the clavicle, from the whole length of the sternum, from the cartilages of 8 ribs and the upper of linea semilunaris. Two additional strips were differentiated, a superior from the 4th and 5th ribs and a fascia stretched vertically between them, an inferior from the 5th rib close to the cartilages; these fused with the rest of the muscle opposite the lower border of the axilla[4].

The clavicular portion was not separated by a depression from the sternal portion, which depression is mentioned in man in several works, *e.g.* by Vrolik and Ellis. Macalister found no such separation in his CHIMP. It was inserted as in man. In AN. it was as in man with two exceptions; 1st, the clavicular origin extended only one-eighth of the length of the clavicle from its sternal end; 2nd, it was not distinctly differentiated from the lesser pectoral, as will be described.

The *Lesser Pectoral* in CHIMP. was distinct from the greater Pectoral, rose from the ends of the 1st, 2nd, and 3rd ribs, the aponeurosis between them, and an aponeurosis from the end of the 4th rib, by which its origin extended mesiad as far as the costal cartilages. It ended in a round tendon, which was inserted into the capsule of the joint, together with the insertion of the supra-spinatus[5].

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sternal part is smaller in Cercopithicus, still smaller in Macacus (rhesus, sinicus, nemestrinus, and cynomolgus) and Inuus silvanus. Vrolik did not find it in Innus. It was the smaller in my An.

[1] It is found in all mammals below Man. Macalister (*Pr. I. Ac.* x. p. 124) says it occurs in one out of sixty human subjects. It seems to be correlated with a quadrupedal gait. It usually rises from the transverse process of the atlas, and sometimes the two following vertebræ; and is inserted into the acromion. It sometimes moreover (as in the rabbit) rises from the basi-occipital.

[2] The intermediate tendon, Vrolik says, "manque chez le macaque, le magot, et le babouin." Macalister (p. 343) found it as I did, but feeble. He also found it in Inuus and Macacus cynomolgus, and in Cynocephalus porcarius and hamadryas. Vrolik, he says, did not find it in Inuus and Cynocephalus.

[3] Macalister found it marked with a tendinous inscription, which was not present in mine.

[4] Wood (*Pr. R. S.* 1866) describes in a human subject a separate slip rising from the sixth rib, and compares it with "the so-called chondro-epitrochlear muscle of apes and monkeys."

[5] Wood found it giving a tendinous slip in several human subjects to the

In AN. the lesser Pectoral was not a separate muscle, but was represented by the deep portion of the great Pectoral. Its coracoid insertion was also feeble, and only gained by the intermediation of fascia. (These fibres are described in man by Henle as running vertically over the bicipital groove.) It also had an extended insertion along the external edge of the bicipital groove.

In CHIMP. a distinct fibrous band ran from the coracoid to the sternum between the articulation of the clavicle and the first rib. This is said by Rolleston and others to be the representative of the *Long Coracoid* of birds, monotremes, and reptiles. It partially fused at its anterior end with the sheath of the subclavius muscle (part of the costo-coracoid membrane), but eventually crossed it, and was inserted more anteriorly than the origin of the subclavius. It has been found by Gegenbaur to contain cartilage cells, but there were none in my CHIMP., though their absence may perhaps be accounted for by its adult age. A similar elastic band has been found in a Drill by Pagenstecher.

Subclavius was in both as in man.

Scalenus anticus in CHIMP. from the transverse processes of the 4th to 7th cervical vertebræ instead of from the 3rd to 6th as in man. It was inserted, as in man, into the "tubercle" of the 1st rib.

Scalenus posticus did not extend below the 1st rib, as is does in nearly all the lower monkeys. In Macalister's CHIMP. it did not extend below the 2nd rib. In AN. the division called posticus (proper) was inserted into ribs 3, 4, and 5.

The supra-pleural fascia (Quain, II. 894) was well developed in CHIMP.

Rectus Thoracis[1] absent in CHIMP., as also in Macalister's[2], rose in AN. from the inferior edge of the 1st rib opposite the insertion of the Scalenus anticus and the manubrium sterni, by a short, flat tendon, as far as the 3rd rib, where it again became tendinous, and was subsequently succeeded by the upper fibres of the Rectus abdominis[3].

Deltoid in CHIMP. arose as in man, and was inserted into the deltoid impression on the exterior side of the humerus, the upper

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greater tuberosity of the humerus. Humphry (this *Journal*, I. 266) found its insertion extending across to the great tuberosity of the humerus in his Chimp.; Wilder found it inserted into the coracoid on the left, and into the humerus on the right side of his.

[1] *Camb. Journ. of Anat. and Phys.* May, 1868, p. 393, 4. Henle, p. 95.

[2] P. 346.

[3] From a simple case like that before us we should call the above muscle a prolongation of the rectus abdominis; but on viewing it as it appears in other animals (*e. g.* the crocodile), it seems on the whole to be a divaricated superior portion of the external oblique. It is however also said by Prof. Turner (*P. R. S. Ed.* 1866—7, p. 65) to be closely allied to the Panniculus carnosus; and he calls it "musculus sternalis," S. "sternalis brutorum." It should be mentioned that the inner layer of the greater Pectoral abutted at the upper end of its sternal attachment on the tendinous origin of the "Rectus thoracis," as it expanded to reach the manubrium, and below was continuous by means of an aponeurosis with the upper prolongation of the Rectus abdominis mentioned above.

end of its insertion being just continuous with the lower and external part of the insertion of the Pectoralis major (*i.e.* the part rising from the clavicle)[1]. In AN. it arose from nearly the whole of the clavicle.

Latissimus dorsi in CHIMP. arose from the spines of the 9th to the 13th dorsal, and all the lumbar vertebræ (4) from the supraspinous ligament of that extent, from more than the outer half of the iliac crest, from the 10th to the 13th ribs, was connected with the tendons of the dorsal muscles, and with the External Oblique. It was inserted into the inner border of the bicipital groove, just internal to and alongside of the insertion of the Teres major, a few of the tendinous fibres being common to both insertions.

In AN. it differed from that in man in not interdigitating with the External Oblique, but having a long straight aponeurotic origin on its ventral aspect about midway between the angles and cartilages of the ribs (the interdigitations seem to be replaced by the muscle mentioned under Serratus magnus), by failing to reach the iliac crest by nearly two inches, arising instead from an aponeurosis joining some of the lower fibres of the External Oblique, and lower down from a lumbar aponeurosis, which extended down to the iliac crest[2]. Half-way down it sent a tendon upwards, which joined the lower end of the inner division of the Coraco-brachialis[3].

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[1] In Humphry's, but not Macalister's, Chimp., it was continuous with the Triceps and Brachialis anticus.

[2] *Dorso epitrochlien* in Chimp. rose from the internal side of the tendon of the Latissimus dorsi, about two inches before its insertion, and was inserted in the internal condyle of the Humerus. Macalister (p. 344) found it ending in a fascia at the middle third of the arm, shorter than in most Quadrumana. Bergman and Halbertsma describe its anomalous occurrence in man. In mine, the muscular fibres extended down the upper two-thirds of the arm. With regard to the claims of the Dorso-epitrochlien to be considered a separate muscle, and not a part of the Latissimus dorsi, the strongest arguments are derived from the innervation. The Dorso-epitrochlien was supplied by a branch which was given off by the Musculo-spiral nerve soon after its origin; from the same branch a factor was given off which joined the Ulnar nerve just before this sent twigs to the inner head of the Triceps. The Latissimus dorsi, on the contrary, was supplied separately by a branch of the long Subscapular nerve, which arose higher, being given off simultaneously with the Musculo-spiral, but not from it.

[3] Vrolik describes the above-mentioned slip as being muscular, and as starting from the Coraco-brachialis, but wrongly says: "Il va se confondre avec la portion interne du triceps." A glance at his figure (IV. e.) shows that he has mistaken the Dorso-epitrochlien (f.) for the inner head of the Triceps.

The Dorso-epitrochlien is represented (Henle) in man by a constant tendinous band connecting the long head of the Triceps with the Latissimus dorsi, and crossing over the Teres major. This band represents its upper or proximal portion, and presents an instance of histological substitution. Its distal, or lower portion, is represented, as it seems to me, in man by the intermuscular septum above the internal condyle of the Humerus from which fibres of the Pronator radii teres often arise; these same fibres taking origin in our Chimp. (as will be hereafter shown) from the lower part of the tendon of the Dorso-epitrochlien. Prof. Rolleston has kindly pointed out to me an account, in a book of notes kept in the Biological department of the Oxford Museum, from which I quote the following extract: "In a child dissected, March, 1862, a distinct tendinous band passed down from the broad tendon of the Latissimus dorsi to the anterior surface of the long head of the Triceps, which it left at

This muscle was well developed in AN.

Levator anguli scapulæ in CHIMP. arose as in man from the posterior transverse processes of the first and second cervical vertebræ, but differed from that in man in not having a fascicle from the third. The superior fascicle split, just before its insertion into the superior inch of the posterior border of the Scapula, into several small factors. The second fascicle was inserted with the most inferior portion of the first fascicle.

Rhomboideus minor in CHIMP. was separate from the Rhomboideus major[1], and was as in man. In AN. the Rhomboidei were feebly separated, and the Rhomboideus minor extended up the ligamentum nuchæ to the occiput.

Rhomboideus major in CHIMP. rose and was inserted as in man, its tendon of origin fused with the overlying Rhomboideus minor. A curious and complicated fascicle, which must be considered as part of the Rhomboideus major, rose, *first*, from the spines of the 4th and 5th dorsal vertebræ, that from the 4th being fused with the most posterior part of the origin of the Rhomboideus major, joining it on its deep surface: *secondly*, from the spine of the 8th dorsal vertebræ. From the first origin a muscular slip, 1½ in. long, stretched backwards and outwards; from the second origin a flat tendon, ½ in. long, ran forward and outwards, and these met at a right angle opposite the 7th dorsal vertebra. From their junction a muscular band ran directly outwards like the stem of a Y, the two origins forming the two branches. This portion was 3 in. long, and was inserted into the most posterior or inferior angle of the Scapula with the most inferior part of the Rhomboideus major. At an inch from its insertion a few muscular fibres ran directly forward to fuse with the posterior part of the Rhomboideus major. An inch farther from the insertion the muscle took a third origin from the subjacent fascia, but not from the subjacent ribs.

No special nervous slip supplied any of the above.

In AN. no such muscle was found, and the Rhomboideus major presented no points of note.

Serratus magnus in CHIMP. was stronger than that in man. It was formed of three portions. The *first*, or lowest, arose from the 1st to the 10th ribs, instead of, as in man, from the 4th to the 8th or 9th[2]. It was inserted into the posterior or inferior angle of the Scapula. The *second*, or middle portion, radiated from its costal origin, and its digitations were only slightly marked. It rose from the 1st and 2nd ribs and intermediate fascia, instead of, as in man,

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right angles. The muscular slip which represents this in the monkey was quite distinct from the long head of the Triceps in the Cercopithecus cynosurus, and in the Hapale penicillata."

[1] Vrolik (p. 18) says the Rhomboids are not differentiated, but his was a young specimen. Macalister (p. 343) says the same, and states that this often occurs in man.

[2] Macalister found it rising from ribs five to twelve inclusive. Wilder, from ribs five to eleven, and from the fascia covering the Intercostal muscles, by slips, of which the lower seven interdigitated with corresponding slips of the External oblique.

from the 2nd and 3rd ribs. It was inserted into the whole of the base of the Scapula, with the exception of the inch or so occupied by the insertion of portion 1. It was therefore commensurate with the insertion of the Rhomboideus minor and Levator anguli scapulæ. The *third* portion, which also arose from the 1st rib, and, by fusion of its tendon of origin with that of portion 2, also from the 2nd rib, was overlapped by portion 2, and was inserted into the anterior or superior inch of the posterior or dorsal border (base) of the Scapula opposite the insertions of the Levator anguli scapulæ. A small fascicle, rising from between the insertions of the Ilio-costalis, Longissimus dorsi, and Splenius colli, opposite the 5th cervical vertebra, was inserted into portion 3 just an inch from its origin from the 1st rib. It seems to come under the category noted by Professor Wood, under the head of "occipito-scapular."

In AN. it differed from that in man in having 3 costal attachments instead of 9. Of these the 1st was inserted into the 1st rib in nearly its whole length, the 2nd into the 2nd rib and fibrous tissue between the 2nd and 3rd, the 3rd into the 3rd rib. Of these the upper may be said to be again subdivided almost equally by an aponeurosis. It thus extended only as far down as the 3rd instead of the 8th rib, as in man. This latter difference, however, was not at first sight conspicuous; for a second muscle, seen on examination to belong to a deeper layer, extended down to the interspace between the 8th and 9th ribs[1].

Supraspinatus and *Infraspinatus* in both were as in man.

Teres minor in CHIMP. differed from that in man, by rising from the middle third instead of the anterior two-thirds of the ventral edge and adjacent part of the infraspinous fossa of the Scapula. In AN. it was as in man.

Teres major in CHIMP., larger than in man, rose from the posterior or dorsal 2½ inches of the posterior edge of the Scapula and the adjacent part of the infraspinous and subscapular fossæ, abutting on, and partially overlapped by, not separated by an inch from the long head of the Triceps. It was inserted as in man. There was no such connection with the internal head of the Triceps as is described by Duvernoy. In AN. it arose from the posterior half of the Scapula.

Triceps and *Biceps* in both were as in man.

Coraco-brachialis in CHIMP. was divided into 2 parts, by a cellular interval, 1½ in. long, through which the Musculo-cutaneous nerve passed. The inner of the 2 divisions thus formed was fused with the coracoid head of the Biceps[1]. In An. it was soon divided into two portions, of which one was inserted into the neck of the Humerus on the inner side of the inner edge of the bicipital groove, and corresponded with the 3rd human variety of Wood. The other portion was inserted into the middle fifth of the inner side of the Humerus, just anteriorly to the origin of the inner head of the Triceps, and in a line between that and the Brachialis anticus. It seemed to correspond with Wood's 1st variety. It was divided from the Biceps by the Musculo-cutaneous nerve, which did not pierce the muscle as normally in man, or as it did in Chimp.

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[1] This remarkable slip is not found in man, nor was it present in my Chimp. It was seen to rise from the angles of the first to the seventh ribs beneath the Serratus magnus in a line between the origins of the Longissimus dorsi and Sacro-lumbalis, and was attached to ribs four to nine. It seemed to be a specialisation of the external intercostals.

In an adult An., examined with a view to ascertain the constancy of some of the peculiarities noticed in this young animal, the Serratus magnus was found to extend to the tenth rib, but the additional slip noticed above was absent.

Henle mentions a deep layer to the Serratus magnus rising from the first or second rib, but fusing with the deep surface of the muscle. A somewhat similar arrangement was found in the Pectoralis major of my Chimp.

Brachialis anticus in both as in man[2].

Subanconeus in Chimp. as in man.

Anconeus in both as in man.

Supinator radii longus in both as in man.

Extensor carpi radialis longior in both as in man, except that in An. the muscular belly was not differentiated from Ext. c. r. br. In Chimp. the remainder of the superficial extensors had, as in man, a common origin, and were not differentiated till they had passed one-third down the forearm. It will be best to follow the description of the arrangement in the human subject, and to note the differences[3].

Extensor carpi radialis brevior as in man.

Extensor communis digitorum in Chimp. as in man, except that the little finger of the *right* hand received only a slip from the tendon going to the ring-finger, just opposite the metacarpo-phalangeal articulation[4].

Extensor minimi digiti in Chimp. was as in man[5]. In An. it differed considerably from that in man. Rising in common with the Extensor communis digitorum from the external condyle of the Humerus, but also from the fascia covering the upper end of the Radius, it passed down through its proper ring in the annular ligament, to be inserted into the outer side of the base of the 1st phalanx of the little finger, and by a second tendon into the outer side of the base of the 1st phalanx of the ring-finger. This arrangement has been noticed in the human subject by Wood and Vesalius (see note 5 in preceding page).

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[1] This arrangement has been noticed in man by Wood (*Camb. Journ. of Anat. and Phys.* 1867, p. 46), and called by him Variety 2. There was no third Variety of Wood (also known as Coraco-brachialis brevis vel superior, and Rotator humeri). Macalister found a rudiment of it in his Chimp., and he says he has found it represented in all Quadrumana. A slip which I have mentioned under "Dorso-epitrochlien," found by me to be tendinous, by Vrolik to be muscular, joined the inner division of the Coraco-brachialis with the Dorso-epitrochlien. This is described by Wood in Variety 2.

[2] Rolleston found in both arms of a Chimp. a muscular slip parting from the upper and outer part of this muscle, and losing itself in the fascia of the forearm. This is not noticed by Vrolik or Duvernoy, nor did I find it in my specimen.

[3] Vrolik, while professing to do this ("de même que chez l'homme), has described a superficial Extensor Indicis. Now, while it is true that this fascicle was as distinct as that of the Extensor carpi radialis brevior, it is also the fact that careful dissection will distinguish an Extensor medii digiti, the muscular fascicle of which was however covered by the fascicle supplying the Index on one side, and by that supplying the little finger (Extensor minimi digiti) on the other.

[4] Macalister, Vrolik, and Moore found no tendon to the little finger. Macalister and Wilder found the tendons not readily divisible: they were readily divisible in mine. This slip, as well as one between the ring and middle fingers (less well marked in the Chimp. than in man), is present in man in addition to the proper tendon to the little finger.

[5] This muscle was found by Rolleston in the Chimp. Wood has found in the human subject cases of two tendons, two muscles, and an additional tendon to the ring finger. Vesalius (I. 258) describes a tendon of this muscle going to

Extensor carpi ulnaris in CHIMP. as in man[1]. In AN. it had no origin from the ulna.

Supinator radii brevis in both as in man.

Extensor ossis metacarpi pollicis consisted of two quite separate bellies (as its homologue, the Tibialis anticus, did in the leg), having the same 2 insertions as the single muscle in man. Of these bellies that into the Trapezium, and the prolongation by a tendinous slip into the Abductor pollicis (noticed under that muscle), had the more superficial origin[2]. In AN. it was not double, but had a double insertion into the Trapezoid bone and the base of the metacarpal bone of the thumb, its tendon containing a sesamoid cartilage (replaced in man by a bursa mucosa) in relation with the quadrupedal habits of the animal.

Extensor primi internodii pollicis was absent in both[3]. In AN. its absence was more easily detected on account of the singleness of the Ext. met. poll.

Extensor secundi internodii pollicis in CHIMP., as often in man, gave a slip to the first phalanx also. It rose from the 2 in. or 2½ in. in the middle portion of the Ulna, instead of from its lower half. In AN. it was as in man.

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join the tendon of the Extensor communis to the ring finger in man. Macalister found it in the CHIMP., sending a single tendon to the little finger only.

[1] Macalister found a tendon which he calls "Ulnaris quinti" prolonged to the first phalanx of the little finger; as in the case of the Peroneus brevis (the homologue in the leg of the Extensor carpi ulnaris) in my CHIMP. This is also mentioned in man by Theile and Wood.

[2] The muscle is described by Vrolik (p. 20) as two muscles which he calls "petit Extenseur" and "grand Abducteur." He also found an additional tendon inserted into a sesamoid bone between the Scaphoid and Trapezium, the two others being inserted into the base of the metacarpal bone and the Trapezium respectively. Humphry found one tendon inserted into the Scaphoid and metacarpal (which in mine and Macalister's ended in the Trapezium), the second attached to the metacarpal. He says, Vrolik, Wilder, and Wyman found the same arrangement as Humphry. The muscle has been found in man double, and also sending a slip on to the Abductor pollicis, by Wood. (*Pr. R. S.* 1866.)

[3] Henle says that this muscle sometimes increases its size at the expense of the Extensor ossis metacarpi pollicis, which would represent exactly the reverse state to that which obtains in the CHIMP. The two cases show, however, the interdependence of these muscles. Rolleston found the muscle present in a CHIMP. In my CHIMP. two apparently separate muscles which crossed the tendons of the radial extensors of the carpus, and seemed to be from their position the Extensores ossis metacarpi and primi intermodii pollicis, respectively, were really the two separate divisions of the Extensor ossis metacarpi pollicis, as was shewn by their insertion.

Extensor Indicis as in man in CHIMP.[1]. In AN. it gave a tendon to the middle finger, as well as to the Index.

Flexor carpi ulnaris as in man in CHIMP. In AN. it rose from the internal lateral ligament, as well as from the condyle; the second rose from the Olecranon and the upper end only of the inner and anterior border of the Ulna.

Palmaris longus in both as in man; it was partly inserted into the anterior annular ligament, as in a CHIMP. dissected by Rolleston.

Flexor carpi radialis in CHIMP. as in man, except that its tendon was not free from muscular fibres till it reached the annular ligament. In AN. it was as in man, but relatively smaller.

Pronator radii teres in CHIMP. was inserted lower down the Radius than in man, and some of its fibres rose from the tendon of the Dorso-epitrochlien[2]. In AN. the second head of origin from the coronoid process of the Ulna was absent.

Flexor sublimis digitorum in CHIMP. as in man, with the following exceptions, which were the same in both hands. The fascicles to the different digits were more differentiated proximally than in man, and the tendons were much longer. The fascicle to the middle finger alone, instead of those to the middle and ring fingers, took an additional origin from the Radius[3]. In AN. it had no origin from the coronoid process of the Ulna and the oblique line of the Radius. Traced upwards from under the annular ligament the tendons developed muscular bellies; at middle of the forearm the muscle split into two portions; the radial side subdivided. One subdivision fused with the Fl. c. r., and ran with it and the Pronator radii teres to the internal condyle. The other subdivision fused a little further on with a slip (which was a proximally extended representative of a common arrangement found in man, and called "Fasciculus exilis" by Henle[1], extending from this muscle to the Flexor longus pollicis or Flexor profundus digitorum), which ran from the internal lateral ligament and internal condyle to fuse with the Flexor prof. digit. with which it had a common origin. The other primary portion fused first with the Fl. c. u. and then with the Palmaris longus, with both of which it rose from the internal condyle and internal lateral ligament.

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[1] It was found by Rolleston and Duvernoy, but not by Vrolik; Macalister and Humphry found a second tendon to the middle finger. Wilder found it as I did. See Wood for human varieties. The old dictum that "no ape can point" is therefore abundantly disproved.

[2] This latter difference, however, was only apparent, for these additional fibres rise in man (when they are present) from an intermuscular septum above the internal condyle of the Humerus, having the same position as the tendon of the Dorso-epitrochlien in the CHIMP., and seem to me to furnish the means of identifying the above-mentioned intermuscular septum in man as the homologue of the tendon of the Dorso-epitrochlien. (For further particulars see under the Dorso-epitrochlien. We shall find a parallel instance in the tendon of the Glutæus maximus, which furnishes origin to some fibres of the Vastus externus.) The two heads of origin in the CHIMP. were divided and innervated by the Median nerve, as in man.

[3] Macalister found no radial origin. In Rolleston's CHIMP., the only fascicle with a radial origin was that to the *Index.* I can find no other instance of this in man or monkeys: it throws much light on the way in which a muscle may, so to say, transfer its origin; as, for instance, the Flexor hallucis does, the homologue of which in the hand rises from the Radius, while it rises from the Fibula, the homologue of the Ulna. In my AN., as will be seen on referring to the description of the Flexor longus hallucis, the latter muscle is seen in the process of transference, having half its fibres of origin from the Tibia. By the time that man was evolved, the origin of this muscle had, however, quite established itself on the Fibula alone, for Henle remarks that it is very invariable. The case plainly put is this: In the same muscular stratum a fascicle rising from one or other side is, as a rule, differentiated to a definite digit or insertion; this fascicle, however, by not constantly arriving at the same destination, reminds us that the muscular stratum to which it belongs was originally undifferentiated, and was capable of a variety of differentiations. The fascicle to the little finger arose from the internal condyle of the Humerus, not in common with the rest of the Flexor sublimus digitorum (except by a small tendinous band), but in common with the Flexor carpi ulnaris. Macalister says Mr Moore found two tendons to the ring finger, none to the little finger, but

Flexor profundus digitorum in CHIMP. rose (as was also the case with the other flexor muscles) from the superior two-thirds instead of three-fourths of the Ulna. Its insertion also differed in not including a tendon to the Index, which was supplied with one by the Fl. l. p.; as in all the flexors its tendons were longer and the fascicles more differentiated than in man. In both hands the muscular bellies and tendons to the middle and ring fingers were more or less closely connected with each other, and with those of Fl. l. p.[2] In AN. it differed from that it man in rising from the upper two-thirds of the Radius as well as of the Ulna, and in giving a tendon to the thumb (that is, the origin and insertion of the Flexor longus pollicis were merged in this muscle). A muscular slip was differentiated to the little finger, though it was also attached by connecting fascia to the main tendon moving the other fingers.

Flexor longus pollicis rose in CHIMP. as in man, but had two tendons, one to the Index, which was large, while that to the thumb was small[3]. The tendon to the Index pierced the sublimis tendon

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Wilder and Macalister found four tendons as usual. In both man and CHIMP., however, the fascicle to the Index is most deeply placed, then that to the middle finger, then that to the ring finger. In each case the fascicle to the middle finger rising more radially than that to the Index, their tendons cross, that to the Index lying the more deeply. In each case the tendons pass under the annular ligament in pairs, those to the two middle digits lying superficially. In the CHIMP. the fascicle to the Index was somewhat peculiar; rising by two distinct heads from the same origin, viz. that which was common to all the superficial flexor muscles: it developed a tendinous marking on the anterior surface of the more internal of these two heads, which only extended for half an inch, and gave this portion the appearance of being digastric. Careful inspection, however, showed that this tendinous portion took an oblique direction through the fascicle, and appeared again on its deeper or posterior surface. Here it soon again disappeared, but an inch above the point of its disappearance a similar tendinous marking appeared on the superficial or anterior surface of the fascicle, which was continued into the proper tendon. The tendons were inserted into the phalanges as in man.

[1] P. 197.

[2] Macalister found the muscle not distinct from the Flexor longus pollicis. Wilder found them separate in a CHIMP., Duvernoy in a Gorilla.

[3] This want of differentiation is sometimes partly retained in man, as

as if part of the Flexor profundus digitorum, as indeed the whole muscle really is. The muscle was so far differentiated into two that the muscular fibres, which ended in the tendon going to the thumb, extended much farther distally along the common tendon than did those which ended in the tendon going to the Index, and these (so to speak) would soon become separate in their whole course. The origin of the Fl. l. p. from the Radius, of the Fl. l. h. from the Fibula (the homologue of the Ulna), has been noticed under the Fl. s. d.[1]. In AN. it was absent, or rather undifferentiated from the Fl. pr. d.

Pronator quadratus in both as in man.

Lumbricales in CHIMP. as in man, except that the 4th arose not at all from the tendon of the Fl. pr. d. going to the little finger, but from the ulnar side of the tendon going to the ring finger, stretching over the tendon and blending at its origin with that of the Lumbricalis of the ring finger. The 2nd, as often in man, rose partly from the ulnar side of the tendon of the Fl. pr. d. going to the Index. In AN. they were, on the whole, as in man.

Palmaris brevis in CHIMP. (as far as could be seen from the shred of it which alone was left, the animal having been previously skinned) was as in man.

Abductor pollicis in CHIMP. as in man. It was not split into slips. Macalister seems to have found it the same. In AN. it rose by 4 heads, the origin from the annular ligament being subdivided into 3 divisions. We shall find several other instances of reduplication in the muscles of this animal, *e. g.* in the Iliacus, Psoas, Flexor brevis minimi digiti (hand), Extensor brevis digitorum (foot), Abductor hallucis, &c.

Opponeus pollicis in both as in man[2].

Flexor brevis pollicis in CHIMP. as in man[3]. It was supplied, as in man, by the Median nerve.

Under this muscle we must notice the "*Interosseus volaris primus*" of Henle. It rose in CHIMP. from the radial corner of the Os magnum, and from the ligaments covering it, not from the meta-

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observed by Henle, Wood, and Turner, a muscular slip from the Flexor longus pollicis sending a tendon to join the tendon of the Flexor profundus digitorum to the Index.

[1] The tendon to the pollex crossed the other tendons of the Fl. p. d. in Humphry's but not Macalister's specimen. Vrolik found no tendon to the thumb; Humphry found the tendon to the thumb rising as a slender tendon from the palmar fascia and going to the last phalanx of the thumb in one specimen, and in another as a long thin tendon from the ulnar side of the Flexor profundus. Wyman found it as Macalister, Wilder found it conjoined with the Flexor profundus indicis. In both hands of my specimen there was a good deal of tendinous connection at the origin of the tendons with those of the Flexor profundus digitorum going to the middle and ring fingers.

[2] Duvernoy describes it in the CHIMP. as divided into two portions, one rising higher than the other on the annular ligament, and the longer fascicle inserted more externally than the shorter: but this was not the case in my specimen. Dr Embleton found it absent in a young CHIMP.

[3] Macalister found it as I did, but Humphry found the outer portion extending beyond the first phalanx.

carpal directly as in man[1]. In AN. the Fl. br. p. seemed to be as in man.

Adductor pollicis and *Abductor minimi digiti* in both.

Flexor brevis minimi digiti in CHIMP. arose as in man, but was inserted not together with the Abductor minimi digiti but distally to it in the same line, by two tendons, of which the external or radial was more distally inserted than internal or ulnar. It also gave two tendinous slips to the Abductor minimi digiti, with which in man it is often fused. In AN. it was not marked off from the Abductor minimi digiti by the deep branch of the ulnar nerve. The head, rising from the annular ligament, was split into three, placed in axial series (thus furnishing another instance of reduplication of muscles, such as we have noticed), and the ulnar nerve passed between these and the fourth head, which, as part of the muscle in man, rose from the tip of the hooked process of the unciform bone. All of these heads, except the most radially, which was also the most distally placed, of those rising from the annular ligament, were more or less fused during some part of their course with each other and with the Abductor minimi digiti, and were inserted together into the base of the first phalanx of the little finger; the most radially placed (before mentioned) having a similar but separate insertion.

Opponens minimi digiti was in both as in man.

Dorsal interossei in CHIMP. were 4. Abductors from the axis of the middle finger; the "Abductor indicis" was more largely developed than in man. It had a double origin from the index metacarpal, one from the base, the other from about two-thirds of its length. The radial artery, as in man, separated the origin of the metacarpal of the thumb from that of the metacarpal of the Index. It was inserted as in man. The other dorsal Interossei were as in man[2].

Palmar interossei six in number in CHIMP.[3], each rose from the whole of the metacarpal of the digit into which it was inserted, and from the base of the adjacent one, and was inserted partly into the base of the first phalanx, partly into the extensor tendon, more distally than the insertion of the dorsal Interossei. No. 1, chiefly from met. ii., partly from met. iii., inserted into the Index which it adducted. No. 2, principally from met. iii., partly from met. ii., inserted into the middle finger, which it abducted radiad. No. 3 rose principally from met. iii., partly from met. iv., and from an intermuscular septum, described below, inserted into the middle finger, which it abducted ulnad. No. 4, principally from met. iv., partly from met. iii., and from an intermuscular septum at the origin of the Adductor pollicis, inserted into the ring finger, which it adducted. No. 5, principally met. iv., partly from met. v., and from an intermuscular septum, described below, inserted into the ring finger, which it abducted. No. 6, principally from met. v., partly from met. iv., and from an intermuscular septum, inserted into the little finger, which it abducted[1].

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[1] Rolleston found it in his CHIMP. Wood mentions its presence in man.

[2] Macalister found them all as in man. In Ateles fuliginosus, in which the thumb is represented by a rudimentary metacarpal, he found them thus: "Of palmar Interossei there are, 1st, a normal first palmar from the 2nd metacarpal to the Index; 2nd, a thin superficial palmar rising from the front of the 3rd and 4th metacarpals, and inserted into the ulnar side of the first phalanx of the Index; this muscle looks like an Adductor pollicis with a displaced insertion; the other two palmar Interossei are normal. To the metacarpal of the pollex two small muscles are attached, one to the ulnar, one to the radial side, both springing from the second row of the carpus; the inner of these may be an Interosseus primus volaris, or a flexor; the outer is evidently the adductor."

[3] According to Duvernoy they are three in number (*i. e.* he reckons four, including the Adductor pollicis), and all "adduct" to the axis of the middle finger; they rise from the metacarpal bone of the digit into which they are inserted, in its whole length, and partly from the adjacent side of the adjacent metacarpal. It is plain that he only considers those as palmar Interossei which are inserted into digits which have no other slip of insertion from the dorsal Interossei on the same side, viz. the Index, ring, and little fingers. As, however, several other slips, placed on the palmar aspect of the dorsal Interossei, and concealed by them from the dorsal aspect, are provided with distinct

Dorsal interossei in An. (which strictly ought not to be called dorsal, as none had a dorsal origin) rose from the distal part of the palmar ligament, and also from the bases of the metacarpal bones into which they were inserted; the 1st ("Abductor indicis") having also an origin from the base of the metacarpal of the thumb. This muscle had also a raphe, which united it to the other indical (2nd) dorsal Interosseus. They were 7 in number (as Church found the palmar set in the Cebus and Inuus nemestrinus); all the fingers had two, inserted on each side, and alternately abducting and adducting, except the little finger, which had one only.

Palmar rose from the distal part of the deep palmar ligament in common with the dorsal set. They had a common origin, were flat, and concealed the subjacent ones from view. They adducted the little and ring fingers (inwards). According to Church's description[2] of the Cebus and Inuus nemestrinus they resembled the same muscles in those monkeys generally, but differed in number; all were much like those of the Carnivora.

Some general remarks on the Interossei will be found under the description of those in the foot.

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tendons separately inserted, it is better, I think, to describe the palmar Interossei as six in number. Church found seven in the Orang.

[1] The intermuscular septa mentioned above, from which Nos. 3 to 6 partly rose, were those between adjacent palmar Interossei. Since the palmar Interossei in man are all adductors, sc. of the Index, ring, and little fingers, these were represented by the 1st, 4th, and 6th in the Chimp.; the abductors, sc. two of the middle and one of the ring finger, were palmarly divaricated portions of the 2nd, 3rd, and 4th dorsal Interossei of man. They were, however, in my Chimp. quite separate and palmarly placed. Rolleston describes them thus in the Chimp.: "The dorsal Interossei have their two heads from the opposed faces of the metacarpals less intimately connected than in man, and the head from the metacarpal of the digit into which this muscle is inserted, sends its tendon into the fibrous extensor expansion on the dorsum of the digit, whilst the other head has its insertion into the basal phalanx, and having its origin placed dorsally, and connected with both metacarpals at their carpal end, has its insertion palmarly to that of the other head."

[2] P. 9.

Diaphragm was carefully examined in CHIMP., and was found strikingly anthropomorphic; the 4 weak places (2 on each side), in which in man diaphragmatic or phrenic hernia sometimes occurs, viz. on each side of the ensiform cartilage, and also between the origin of the greater muscle from the last rib, and that from the Ligamentum arcuatum externum, were as well marked in the CHIMP. as in man.

LOWER LIMB.

Femur possessed a Ligamentum teres, in both CHIMP. and AN., as in all Quadrumana except the Orang.

Psoas parvus in CHIMP. rose from the last (13th) dorsal and first lumbar vertebræ, was attached to the bodies of the succeeding vertebræ by a fascia which overlaid the Psoas magnus, and received from it and transmitted to Ps. p. a few fibres. It overlaid the Ps. m., and ended in a flat tendon which was inserted into the lower part of the Ilium at the ilio-pectineal line, just where the femoral vessels emerged. In AN. it was well developed, rose from the intervertebral space between the 1st and 2nd lumbar, and from the fascia iliaca and transversalis as far down as the 6th lumbar, where its tendon, which was very strong, began. It was continuous with Poupart's ligament, and was inserted into the whole length of the upper border of the Pubes and lowest part of the Ilium, crossing the Psoas magnus as it left the pelvis. In man this muscle is very variable and inconstant, but generally rises from the last dorsal and first lumbar vertebræ.

Psoas magnus in CHIMP. rose from the last dorsal v., from the inferior surface of the interior inch of the last rib; from the body and transverse process of all the (4) lumbar v. and the tendinous arches passing across the hollow formed by the constricted portions of their bodies, becoming continuous with the Iliacus below this origin. It was inserted with the Iliacus as in man. In AN. it differed from that in man in rising not higher than the intervertebral space between the 1st and 2nd lumbar v. instead of from the last dorsal v. It was in two distinct parts; an external and superior, rising from the intervertebral spaces between the 1st and 2nd lumbar v. and down as far as between the 5th and 6th lumbar v. supplied by the Anterior crural nerve; and an internal and inferior, rising from the intervertebral space between the 3rd and 4th lumbar v. and as far down as the 7th lumbar v. (this increased number of lumbar vertebræ accounts for many differences both of muscles and nerves), supplied by the 3rd lumbar nerve. In man the whole muscle is supplied by the 2nd lumbar nerve. The two divisions were separated by the course of the lumbar nerves. This furnishes another instance of reduplication, and this set of muscles (the two Psoas and Iliacus) was much split up in this animal.

Iliacus rose in CHIMP. as in man, and soon fused with the Psoas magnus, the fibres running obliquely on each side into the Psoas magnus and its tendon, and gradually enveloping it from each side. In AN. it was on the whole the same. Near it were two remarkable slips;

one, which was probably the same as that mentioned by Owen[1] in the Orang (where, however, he does not mention any second origin from the Psoas magnus) was present on the right side, but not on the left in my young AN., and altogether wanting in an adult AN. which I examined specially. It rose by two heads, one from the external factor of the Psoas magnus opposite the 5th lumbar v., the other from the exterior border of the Iliacus, just as it left the pelvic cavity. These formed a round tendon which was attached to the lesser Trochanter on the outer border of the rest of the Ilio-psoas. It resembled those described by Henle and Luschka as "Iliacus internus minor" except in having a psoas origin. It thus formed a *Second Ilio-psoas*, and so far justified Henle in using the term Ilio-psoas in man instead of Iliacus and Psoas. It offers another interesting instance of reduplication. The second muscle rose from the Ilium at the under surface of the origin of the tendon of the Rectus, and from a line drawn from thence across the capsular ligament of the Femur. It was inserted into the line which runs from the upper part of the linea aspera, spirally inwards and forwards, limiting the neck of the Femur, between the insertions of the Pectineus and Ilio-psoas. It was better developed on the left than on the right side. On the right side it was inserted beneath the "second Ilio-psoas," and at the same spot (that muscle being absent, as above stated, on the left side). It was a reduplication of the Iliacus, and, together with the iliac head of the "second Ilio-psoas," represents, or rather is represented, by the "Iliacus internus minor" of Henle and Luschka in man. The Ilio-psoad set of muscles was thus much split up (as were the Glutæi in the CHIMP.); the Psoas magnus consisting of two distinct muscles, and there being a second Ilio-psoas, and a second Iliacus.

Tensor vaginæ femoris in CHIMP. differed from that in man in extending farther down the exterior border of the Ilium at its origin, in relation with the greater length of the Ilium. Its lowest point of origin was marked however as in man by the origin of the Sartorius. It only reached the anterior superior spinous process of the Ilium after fusing, or rising in common with the glutæus medius and minimus externally. Its origin was also common to the Sartorius internally and below, and the Transversalis internally and above. In AN. it rose half way down the anterior edge of the Ilium.

Glutæus maximus in CHIMP. was smaller relatively than in man, but larger than in AN., in correspondence with the more erect gait. It rose from a fascia covering and giving partial origin to the Glutæus medius, and rising from the exterior part of the whole of the crest of the Ilium, and posteriorly continuous with the fascia covering the dorsal muscles; from the Sacrum, sacrosciatic ligament, Coccyx, and ischial tuberosity by an origin shared by the long head of the Biceps. (This ischial origin is described by Duvernoy as a separate muscle which he calls "Ischii-fémorien.") Though it had this extensive origin, its muscular fibres did not reach higher than the sacro-sciatic notch; above this point what is muscular fibre in man was fibrous tissue in the CHIMP. It was separate from the Tensor vaginæ femoris. It was inserted into the whole length of the linea aspera along the origin of the Vastus externus (Henle mentions that in man some of the most external fibres are inserted alongside of the Vastus externus), and also by a distinct tendon into the fascia lata just below the great Trochanter. Its texture was coarse, especially in its lower part. Part of its tendon gave origin to some fibres of the Vastus externus and short head of the Biceps, which in man rise from an intermuscular septum occupying the same position, and which I think serve to identify that septum as the homologue of the tendon of the Glutæus maximus of the higher monkeys. A similar instance I have recorded under the Dorso-epitrochlien and Pronator radii teres. In AN. it was covered by a dense fascia containing much hard yellow fat and clinging very close to the muscle. It rose not higher than the lowest part of the Sacrum and the root of the tail. Its fibres became fused with those of the Tensor vaginæ femoris opposite the great Trochanter (at which point some fibres were given off to terminate in the linea aspera), while the remainder terminated with those of the Tensor vaginæ femoris in the fascia lata. The muscle was weak, especially at its origin.

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[1] *Proc. Zool. Soc.* Part I. (1830—31) p. 69; see also Church, p. 16.

Glutæus medius in CHIMP. was the largest of the three Glutæi, and relatively larger than in man. It rose from the fossa Ilii below the crest in its whole length, and as far down as half the length of the Ilium. Also, opposite the upper fourth of the Ilium, from the fascia above-mentioned, overlying it. It was inserted into the posterior edge of the great Trochanter in its whole length. A small fascicle a quarter of an inch broad separated from its anterior or exterior border, and was inserted into the anterior and distal part of the great Trochanter, on the opposite side of the Vastus externus from rest of the glut. med. In AN. it was largely developed as usual in Quadrumana, and with difficulty separable from the Pyriformis.

Glutæus minimus, the smallest of the three in the CHIMP. (Macalister found it twice as large as the Glutæus medius), rose from a line drawn from one inch below the ant. sup. spinous of the Ilium, to its posterior and inferior extremity, opposite the acetabulum. The fibres from the anterior or superior portion rose from a wider origin than the rest, the line of origin decreasing in breadth as it ran backwards. It had no origin from the coccyx, it could be separated with some difficulty into two nearly equal portions, an interior and deeper, and a posterior and superficial, overlapping the hinder part of the first. From the former of these the Scansorius was differentiated. The tendons, which occupied equal lengths of insertion along the proximal or upper 1¼ in. of the anterior surface of the great Trochanter, were distinguishable but not separate. These two divisions are mentioned in man by Henle. Beneath the Glutæus minimus a small muscle a quarter of an inch broad, and two inches long, quite separate from it, rose from the exterior edge of the Ilium on a level with the uppermost part of the ischiadic attachment of the sacro-sciatic ligament, and was inserted into the anterior edge of the great

Trochanter just opposite the insertion of the second part of the Glutæus medius with which it agreed in breadth. In An. it showed no signs of fission or reduplication; it rose from the exterior of the Ilium within two lines, the upper starting from a point one-third down the anterior edge of the Ilium, and running backwards and downwards to the upper extremity of the sacro-sciatic notch; the lower running from a point two-thirds of the distance down the anterior edge of the Ilium backwards and downwards to a point just opposite the acetabulum. It was inserted as in man.

The *Scansorius* in Chimp. was very imperfectly separated from the Glutæus minimus, the anterior half of which overlapped it. It formed about a quarter of that muscle, being differentiated from the anterior and deep portion, and was inserted together with its most anterior portion into the anterior and distal part of the great Trochanter. It was supplied by the superior Gluteal nerve in common with the rest of the Glutæus minimus[1]. In An. it was undifferentiated[2].

Pyriformis in Chimp. was really, but not obviously, separate from the Glutæus medius. It rose from the lower part of the 2nd, 3rd, and 4th, and upper part of the 5th sacral vertebræ, from the adjacent part of the deep surface of the Ilium, but not from the sacrosciatic ligament. It was inserted into the proximal end of the great Trochanter, being at its extremity slightly united with the tendon of the Glut. med., with which it shared a bursa mucosa. In An. it was nearly fused with the Glut. med.

Obturator internus in both had an origin somewhat more extended, and elongated by the increased length of the iliac bones than in man; viz. from the whole of that part of the brim of the pelvis which was formed by the Ilium and Pubis, except opposite the obturator foramen, where the fibres rose from the tendinous arch which ran below the obturator vessels and nerve, across and below that foramen; from the internal aspect of the long symphysis Pubis, and adjacent part of the lower border of the Ischium as far as the tuberosity; also from the obturator membrane, and from all the internal surface of the Pubis and Ischium mesiad of a line drawn perpendicularly through the obturator foramen. Its tendon was overlapped by the Gemelli and fused with them, and they were inserted together into the digital fossa on the internal and posterior side of the great Trochanter, as in man.

Gemellus superior in both rose from a point just above the trochlear surface of the Ischium, where there was a small rudiment of the ischial spine.

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[1] Vrolik could not find it. Macalister found it one-fifth of the size of the Glutæus medius. Its presence in man is recorded by Wood.

[2] In Chimp. we see a remarkable tendency in the Gluteal set of muscles towards fission or reduplication, such as we found to obtain in many other muscles, which we have noticed as they have been described, but in An. especially in the Ilio-psoad set:—the Glutæus maximus in Chimp. was so far separated into two as to have been described by Duvernoy as two muscles; the Glutæus medius was bifid and had its two parts differently inserted; the Glutæus minimus not only showed the two divisions described in man by Henle, but in addition threw off a Scansorius, and a still more distinct muscle mentioned above, from its deep surface, thus being split into four divisions.

Gemellus inferior in both as usually in man, much the smaller of the two Gemelli. It rose from an origin 2 in. in length, commencing at the most dorsal, posterior, or superior part of the internal ridge of the ischial tuberosity, and ending at the ventral, inferior, or mesial one-third of the same edge.

Quadratus femoris in both arose as in man. It was inserted not into the linea quadrati as in man, but into a horizontal line, extending from the lesser Trochanter outwards, and a little downwards for about three-fourths of an inch. There was, however, about half way along this line a small vertical insertion extending along the posterior edge of the great Trochanter, in a line feebly representing the linea quadrati of man. The upper part of the insertion of the Adductor brevis overlapped the exterior part of the insertion of this muscle.

Coccygeus in CHIMP. was as in man, except that it was readily divisible into two portions. Its insertion was fused with the coccygeal part of the origin of the Glutæus maximus. The perineal muscles had been destroyed in removing the abdominal viscera.

Biceps femoris in CHIMP. was as in man in general. The short head was well developed; the long head rose, as in man, from the most external part of the external edge of the tuber Ischii, its origin being common also to the Semitendinosus, but also, unlike man, to the Semimembranosus which the Semitendinosus overlapped; to the most posterior part of the Gracilis, which the Semimembranosus overlapped and which was much larger relatively than in man, also to the lowest part of the origin of the Glut. max., which in man has no origin from the tuber Ischii. Its tendon ran for one inch before receiving the fibres of the short head. The fusion between the tendons of the two heads was not complete, but the tendon of the long head crossed over that of the short head and was inserted into the outer and anterior tuberosities of the Tibia, as well as into the fascia of the leg, which was continuous at the knee-joint with the fascia lata of the thigh. The tendon of the short head crossed under that of the long head and was inserted into the prominence at the exterior side of the head of the Fibula, and into the fascia of the leg, distally to the tendon of the long head[1]. In AN. the Biceps was very large. Its short head was wanting, as sometimes in man (Henle and Theile) and the lower monkeys. Its insertion was very long, occupying nearly half of the Fibula. It was inserted chiefly into the fascia of the leg, a strong band being given off to the covering the knee-joint, and a less strongly marked one to the outer tuberosity of the Tibia, but there appeared to be no special insertion into the head of the Fibula[1].

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[1] The proper tendon of each of the heads was ¼ in. broad. In the Gorilla and in the Orang the Biceps consists of two distinct muscles, no fusion taking place as in CHIMP. and still more in man. In CHIMP. compared with most other Quadrumana the insertion was very high, and the muscle itself small, an anthropomorphic point. In man there is but one conjoined tendon from the two heads. The original separateness of the two heads was even in CHIMP. plainly indicated by the difference in the mode of their innervation; they were both supplied by the great Sciatic nerve as in man but in a different way. In man this nerve gives off separate branches to the Adductor magnus, Semitendinosus, Semimembranosus, and Biceps. In CHIMP. a separate trunk was formed as the great Sciatic issued from the sacro-sciatic foramen, and after a course of 4 in. gave off (1) a branch which supplied the origin of the Semitend. by several twigs, (2) a branch which bifurcated and supplied the upper one-third

Semitendinosus in CHIMP. rose from the tuber Ischii in common with and below the long head of the Biceps as in man, with which it was fused for its first three inches, and also in common with and superficially to the Semimembranosus, unlike that in man. It differed from that in man in being larger instead of smaller than the long head of the Biceps, and not having a tendinous inscription (which, however, was found by Macalister in his CHIMP.), also in its insertion, which was comparatively much lower down than in man. Vrolik found it inserted as in man. Its tendon proper was inserted into the anterior tubercle of the Tibia, two inches from the top of that bone, and was well marked, flat (it is round in man), and one-third of an inch broad; but about three inches before it reached its insertion it suddenly gave off a wide-spreading expansion (represented in man as observed by Ellis, p. 705) downwards, which was three-fourths of an inch wide at one inch distant from its origin, and the most posterior fibres of which became quite perpendicular. This expansion became continuous with the fascia of the leg. The insertion was overlapped by that of the Gracilis, with the aponeurotic expansion of which it fused. The tendon was not so long as in man, as Vrolik also found[2]. In AN. this muscle rose in common with the long head of the Biceps, and was inserted very low down the leg, much lower than in CHIMP. Two principal tendons were given off, one exactly opposite the upper

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of the long head of the Biceps, (3) it split into branches which supplied the proximal part of the Add. ma., the mesial part of the Semitend. and Semimembr. and the separate external or distal division of the Add. ma. The short head was supplied by two twigs separately rising from the main trunk of the great Sciatic nearly opposite the middle of the thigh. The bearing of this arrangement on the general question of progress as indicated by Integration will be found noticed under the great Sciatic nerve.

[1] The distinctness throughout of the two heads and their tendons in the Gorilla and Orang, as well as their different mode of innervation in CHIMP. and the absence of the short head in the Cebus and Inuus nemestrinus, in AN. and many other Quadrumana, and also occasionally in man, all point to the essential distinctness of the two as separate muscles. The progress from the absence of the short head in the Cebus, Inuus nemestrinus, AN, &c., and the complete distinctness of the heads and their tendons in the Gorilla and Orang, through the partial fusion of the tendons in CHIMP., to the complete fusion in man, is remarkable, and would, as far as it goes, serve as an argument for placing CHIMP. at the head of the Quadrumana.

[2] Cuvier has remarked that in all Mammals below man this muscle and the Semimembranosus possess this aponeurotic expansion at their insertion, and that their insertion is also much lower down the leg than in man, which keeps their knee necessarily bent and is incompatible with an erect gait. The approach to an erect gait is therefore indicated by the removal upwards of their insertions. Professor Rolleston informs me that this comparatively low insertion of the hamstring muscles is still to be seen in young children—a most significant fact.

part of the insertion of the Gracilis, and inserted into the lower part of the anterior tubercle of the Tibia, the lower fusing with the lower end of the Gracilis, and ending with it in the fascia of the leg at a point more than half way down the leg. There was no tendinous intersection.

Semimembranosus in CHIMP. rose as in man. It was overlaid at its origin by the conjoined origin of the Biceps and Semitendinosus, and was fused with that part of this conjoined origin which was continued into the Semitendinosus for one inch, and after that, partly (by several small and separate tendinous slips) for another 1⅛ inch. Its tendon of origin was flat and long, as in man, being 3 inches in length. The muscle was of the same size as the long head of the Biceps, *i.e.* smaller than the Semitendinosus; in man it is larger than either. Its insertion differs from that in man (Macalister, in p. 349), in not possessing a slip expanding into the aponeurosis overlying the popliteus muscle. Between its tendon and the internal lateral ligament of the knee-joint was a bursa. It sent no fibres to this ligament as it does in man. Its tendon of insertion was rounded and small, and reached the Tibia one inch more proximally than the upper part of the insertion of any of the other three hamstring muscles[1]. In AN. it resembled that in man, except that it had no membranous origin and only one insertion, viz. that into the posterior part of the internal tuberosity of the Tibia.

Gracilis in CHIMP. rose from the whole length of the Symphysis Pubis, and the interior inch of the upper edge of the pubic ramus, by a flat membranous tendon half an inch long, which overlapped diagonally and fused with the part of the Add. l. which was adjacent to the most exterior part of its origin. It was inserted just superficially to the insertion of the Semitendinosus and agreed with the latter in the breadth of its tendon proper (half-inch), but differed in having its tendon a little the shorter; it also agreed with the Semitendinosus exactly, in the insertion of its tendon proper into the lower part of the anterior tibial tubercle, 2 in. from the top of that bone, and of a rapidly spreading tendinous expansion into the fascia of the leg. It differed quantitatively in an enormous degree from that in man in every particular, being much larger, as is the case in the orang (Church, p. 10), but agreed qualitatively. Its insertion, like that of all the hamstring muscles except the Semimembranosus, was much lower than in man. It was the largest of the hamstring muscles, and was broad and flat. In AN. it had a wide origin and was not inserted into the inner tuberosity of the tibia, but into the fascia of the leg and anterior ridge of the middle third of the Tibia, straightening of the limb.

Sartorius in CHIMP. was large, and rose from the *lower* part of the anterior edge of the Ilium, and was fused with a few of the fibres of the external part of the Iliacus, with Poupart's ligament, with the Tensor vaginæ femoris, the Gl. min. and the Rectus femoris[2], inserted superficially to the Gracilis, but without a bursa between them. In AN. it rose as in man, but was inserted into the upper half of the anterior ridge of the Tibia and the fascia of the leg.

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[1] Vrolik says it is inserted lower down than in man, but this was not the case in this specimen, nor did Owen find it so.

[2] No such slip from the origin of the Pectineus, passing under the femoral

Rectus femoris in CHIMP. resembled that in man, but rose by one and not two separate tendons as in man[1], inserted as in man, but was more separate from the Crureus than in man. In AN. there were also not two separate heads of origin; the fibres had no penniform arrangement.

Vastus externus in CHIMP. agreed with that in man in every respect, except in its relations to Glut. max. (which see above).

In AN. it was, as in man, except that the short head of the Biceps being absent, it had no origin from an intermuscular septum between the short head of the Biceps and itself.

Vastus internus in CHIMP. rose higher, as far up as the neck of the femur.

Crureus in CHIMP. differed in being more closely connected with the Vastus ext. than with the Vastus int.

Subcrureus in both was absent.

Pectineus in both as in man.

It was not bilaminar in either, but it was found by Macalister to be so in CHIMP.

Adductor longus in CHIMP. was generally as in man. In AN. it arose as in man, but differed slightly in fusing with the tendon of the Adductor magnus.

Adductor brevis in both was in general as in man but relatively larger. It was multi-fasciculate, but in CHIMP. was inserted into the oblique line leading not from the small but the great Trochanter, to the linea aspera. The Obturator nerve pierced it and divided it into two portions, at the same time supplying it as in man.

Adductor magnus in CHIMP. consisted of two distinct divisions, the deeper and larger rose from the whole of the anterior surface of the pubic bone along the Symphysis, and the adjoining part of the Ischium as far as the tuberosity. It was inserted into the linea aspera along the lower half of the thigh, fusing with that of the Add. l. It was multi-fasciculate, and supplied by the Obturator nerve. The superficial and smaller division, more compact, overlapped the preceding below, and arose from the Tuber Ischii by a flat thin ten-

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vessels, as is described by Owen, could be found, but with regard to this connection when it exists, Cuvier's remark on the "castor" (beaver) is not a little interesting: "Le couturier est tout-à-fait confondu dans le castor avec les pectinés."

[1] Vrolik asserts that there are two origins;—in my CHIMP. the tendon of origin arched round the upper edge of the acetabulum (as does the 2nd origin in man), but this portion was not separate. In man, however, the two origins are united by membrane, and in CHIMP. they admitted of being readily separated. It rose from the anterior inferior spinous process of the Ilium (as in man) and from two lines diverging from it on each side like the legs of the letter A, and capping the acetabulum, also from an aponeurosis giving origin in order from above downwards to the Tensor vaginæ femoris, Glutæus minimus, Sartorius and Rectus, and, externally to the origin of the Rectus, to the small muscle mentioned as underlying the Glutæus minimus; by which aponeurosis the origins of all the above-mentioned muscles were connected.

don, and was inserted separately into quarter of an inch on the internal side of the internal condyle of the Femur[1]. In AN. it was multifasciculate, but not in two separate divisions.

Obturator externus in CHIMP. had its origin, in general, as in man.

Gastrocnemius in CHIMP. was as in man and was large, but the muscular fibres were continued as far as the insertion into the calcaneum; see also foot-note[2].

Solæus was large. It rose from the head and upper three-quarters of an inch of the Fibula instead of from its upper one-third. There was no origin from the Tibia[3].

Plantaris in CHIMP. as in man. It was absent in the right leg[4].

In AN. it was fused with the outer head of the Gastrocnemius for half an inch from its origin, and was partly united with it by tendinous slips for one inch further, at this point being connected with the outer head of the Gastrocnemius by a broad fibrous hand. Its muscular belly was longer than either of those of the Gastrocnemius, and its greatest breadth was half that of the Solæus[1].

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[1] Cuvier in his plates draws in a figure of a Magot, an Adductor having a similar but not so distinct insertion (l^2), which he calls "long adducteur," but as he also calls it "Ischii-fémorien" it cannot be homologous with the Add. l. of man (Church has, wrongly I think, translated it "Adductor longus," p. 13), which rises from the Pubis. This fascicle is apparently the same as that here described in CHIMP. Ellis describes two more or less distinct parts of this muscle in man, which differ in the same way in texture and insertion, but are not really separate. In CHIMP. the superficial part of the Femoral artery *divided the two portions* before reaching the popliteal space; and since it *pierces* the Adductor magnus at the same portion of its course in man it furnishes another reason why the distinct second portion in CHIMP. may be identified as part of the Add. magnus, specialised. Moreover, the Obturator nerve supplied the principal portion, the great Sciatic nerve the superficial and smaller division, both of these nerves in man supplying the Adductor magnus. Henle describes a slip somewhat similar to the second portion which I have described.

Burdach describes the 3 Adductors as one muscle in 5 divisions; the Add. m. furnishing two, the Add. l. the 3rd, and Add. br. the 4th and 5th. He also says that Meckel includes the Pectineus as a 6th (could he do so consistently if he had found it bilaminar?).

[2] Church says that in the Orang it is small and often separate from Solæus; in Inuus nemestrinus it was more separate than in the cases in which it was found to be fused in the Orang. The only points in the CHIMP. worth remark are that the inner head was fused with the insertion of the second portion of the Add., this head neither being separate nor extending so low as in man. A bursa underlaid this head and communicated with the knee-joint as in man. No sesamoid bone or fibro-cartilage could be found in the external head. The tendon slightly differed from that in man, in that the muscular fibres were continued as far as the insertion into the Calcaneum (Macalister's CHIMP. differed in this respect from mine, while Wilder's agreed with it), running on each side into the tendon which lay in the middle.

[3] The tibial head was absent in a CHIMP. dissected by Macalister (the fibular origin being very large). It is absent in AN.; in the Orang and Cebus (Church, p. 14), and the Gorilla (Duvernoy, p. 93). In the Inuus nemestrinus it rose from the fibula and external condyle of the Femur. Vrolik mentions in CHIMP. a tibial but no fibular origin. The tibial head was found by Humphry in a CHIMP. The fibular origin was found a mere slip in CHIMP. by Humphry and Huxley, and by Church in the Orang.

[4] Macalister found it very small, present in the left leg, absent in the right, the opposite arrangement was found by Wilder. Vrolik found it as well as Huxley and Humphry; it was absent in Traill's specimen. In the Orang (Church, p. 14) it was absent, also in the Cebus; it was large in the Inuus nemestrinus and arose as in the CHIMP. Duvernoy says it is absent in the Gorilla and Orang. It is often absent in man. It was absent in a young CHIMP. dissected by Dr Embleton.

Popliteus in CHIMP. as in man.

In AN. a small slip of muscle, not found in an adult AN. specially examined, but present in a Wanderoo (Simia ferox), ran from the upper (external) head of the Popliteus to the internal head of the Gastrocnemius.

Flexor longus digitorum in CHIMP. arose as in man. Its tendon was more fused with that of the Fl. l. h. It could be seen, that, but for the fusion above mentioned, this muscle would furnish tendons only to the 2nd (index) and 5th toes[2].

In AN. it was the sole mover of the index and little toes, but moved the others by its intimate connection with the Flexor longus hallucis. It also sent a distinct slip to the tendon of the Flexor longus hallucis going to the hallux.

Lumbricales. Most of these muscles in CHIMP. took origin both from the tendons proper of the Fl. l. d., and those of the Fl. l. h. That one, however, which went to the 2nd toe rose only from that of the Fl. l. d. It was the largest. That one which went to the 3rd toe rose by two heads, one from the tendon of the Fl. l. d. going to the 2nd, principally from the fibular, but partly also from the deep and tibial aspects; the other from the tendon of the Fl. l. h. going to the 3rd toe, from the internal, and internal half of the superficial surface. That one which went to the 4th toe rose from the tendons of the Fl. l. h. going to the 3rd and 4th toes, from the adjacent halves of their superficial aspects, and the adjacent sides. That one which went to the 5th toe rose from the tendon of the Fl. l. h. going to the 4th toe, from its superficial aspect, and fibular side, and by another small belly, from the adjacent half of the superficial surface and tibial side of the tendon of the Fl. l. d. going to the 5th toe. Most of these reached proximally as far as the division into separate tendons, and extended distally for three quarters of an inch, but the small belly of the Lumbricalis of the little toe had only a minute origin which was attached about three quarters of an inch from the division of the tendon of the Fl. l. d. going to the little toe.

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[1] In contrasting the muscles of the tendo Achillis in CHIMP. and AN., we find the general arrangement very anthropomorphic in the former, very much the reverse in the latter, but there are some exceptions. For while AN. has a smaller Gastrocnemius, the heads of which are separate far down, on the other hand its tendon is longer; the muscular fibres quite ceasing half way down the leg, though AN. was a young one. In both the Solæus has only a fibular origin. The Plantaris is large and partly fused with both the Solæus and both heads of the Gastrocnemius in AN., but is small and separate except at its origin in CHIMP. as in man. In AN., however, the tendons of all three muscles remain separate till just before their insertion, when they simultaneously fuse; in CHIMP. as in man the Solæus is fused during nearly its whole extent with the Gastrocnemius, the Plantaris being separate at least in its muscular portion; its tendon also not fusing completely till just before insertion.

[2] Duvernoy describes in the Gorilla the Flexor longus digitorum sending tendons to all the digits. Church found it in the Orang sending tendons to the 2nd, 4th and little toes, and sending no slip to the tendon of the Flexor longus hallucis. In my CHIMP. it was inserted as in man, and in the same way as the Flexor profundus in the hand.

They were inserted as in man, and were quite as well developed as those of the hand, in which point they differed from those in man, which in general they resembled. The chief differences were those of origin, which were due to the continuance of tendons from the Fl. l. h. to all the digits except the index and little toes[1].

Flexor accessorius in CHIMP. in both feet rose from the Calcaneum, a little anterior to the internal tubercle (by one head, not two as in man) and stretching inwards and forwards was inserted into the external edge of the tendon of the Fl. l. d. just before the fusion with the tendon of the Fl. l. h. The tendon was much longer, and smaller than in man[2]. In AN. it was well-developed, and was present also in an adult AN. specially examined, and rose from the fibular side of the middle part of the plantar surface of the Calcaneum by a fleshy head, and from the adjacent corner of the Cuboid by a tendinous head; and was inserted into the outer side of the point of intercommunication of the common tendons of the Fl. l. d. and l. h., thus running diagonally across the Calcaneum.

Flexor brevis digitorum in CHIMP., a very complicated muscle. The principal portion rose from the inner side of the os-calcis as far as the tuberosity, and from the deep surface of the plantar fascia, by which it was connected with the origin of the Abductor pollicis. Two minute tendons were sent from that going to the third to fuse with the tendon of the flexor brevis going to the second (index) toe, just mentioned, which they did opposite the metacarpo-phalangeal articulation, one of them developing about half-way a very small muscular belly. A small muscular belly was also detached from the main portion, and ended in a tendon which fused with the tendon to the 4th toe. This last rose from the surface of the tendon of the Fl. l. d., as far as the internal malleolus, and was chiefly inserted into the 4th toe. A portion of it joined the tendon before described going to the 3rd toe. A small slip also rose from the tendon of the Fl. l. d. to the little toe, and was inserted indistinctly, being much fused by fibrous tissue, with the tendon of the Fl. l. d. going to the little toe. The fascicle to the little toe is most irregular in its arrangement in the Quadrumana and in man.

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[1] Duvernoy says, that only the Lumbricalis of the 2nd toe arises from the corresponding tendon of the Flex. long. dig., the others rising from the tendon of the Flex. long. hal. Dr Embleton mentions "a small muscle accessory to the Lumbricales arising from the long Flexor tendon before its division." He gives no further account of it. Could it possibly be that part of the Fl. br. d. which sent a tendon to the 4th toe in mine?

[2] This muscle was absent in Rolleston's and Embleton's specimens. Humphry found it small in both feet of one CHIMP. In another CHIMP. it did not reach the flexor tendon in one foot, and was absent in the other foot. Church found it in the Orang, sending a tendon to the tendon of Flexor longus to the little toe, and another, which accompanied that tendon, and, after being perforated by it, was inserted into the second phalanx of the little toe. Humphry could not find it in Orang, but found it large in Ateles. In AN., Cebus, and Inuus nemestrinus, it fused with the tendon of the Flexor longus digitorum, as in man.

The coexistence of this muscle with the irregular slips described under Fl. br. d., which have been stated (as by Vrolik, and apparently by Church, as above) to partly represent the Accessorius, tends to establish their nature as that of scattered portions of Fl. br. d., as hereafter described, and at any rate in CHIMP. disproves their homology with the Moles carnea.

In An. the Fl. br. d. was very different from that in man. It consisted of the following parts: (1) a long head rising from the lower surface of the Calcaneum, in common with the Abd. p. and Abd. 5ti as well as to fascicle 2. It was inserted into the 2nd toe. In the left foot but not in the right, it received two minute slips from the next. (2) A compound fascicle from the conjoined tendon of Fl. l. h. and Fl. l. d., and consisting of one proximal and distinct belly, and three other distally placed and less distinct bellies; they ended in a tendon inserted into the 3rd toe. In the right foot, but not in the left, the first and second bellies of portion 2 each gave a small tendon to the conjoined tendon of Fl. l. h. and Fl. l. d. (3) from a similar and parallel origin inserted into the 4th toe. The last two received slips from the plantar fascia. (4) A small fascicle in the left foot, from a belly common also to portion 3 (in the right foot rising separately), inserted into the 5th toe.

Tibialis posticus in Chim. rose as in man. Its tendon split more definitely than in man into two, one of which was inserted into the Scaphoid, the other into the Ecto-cuneiform bone. No sesamoid body could be found in its tendon, as is usual in man. In An. as in man, except that its tibial origin did not extend so far down as that of the Fl. l. d.

Flexor longus hallucis in Chimp. rose as in man, except that the origin of the Solæus not extending down the Fibula for more than one inch, all below this was occupied by it. Its tendon, besides furnishing a tendon to the Hallux, furnished one to the 3rd and 4th toes[1]. In An. this muscle rose equally from Tibia and Fibula, from the latter of which in man it is separated by the Tib. post. This tibial origin, which was paler, explains the fact that the Fl. l. p. rises in man from the radius, the Fl. l. h. from the Fibula; we here, as it were, see the muscle transferring its origin[2]. The tendon was intimately fused with that of the Fl. l. d., so that the action of either muscle bent all the toes. As usual in Quadrumana it supplied the middle and fourth toes as well as the Hallux. The tendon to the Hallux, which passed through a ligamentous ring giving partial origin to the inner head of the Flexor brevis hallucis, received a slip from the tendon of the Fl. l. d. Theile mentions a similar slip in man.

Peroneus longus in Chimp. as in man, but strong, and the fleshy fibres extended to the malleolus. In An. it was as in man, except that it rose from the upper half of the Fibula, instead of from the upper third.

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[1] The descriptions by various authors shew that these two muscles in Quadrumana vary greatly in their relations to one another and in the toes they respectively supply. See Vol. I. of this *Journ.* p. 266.

[2] In man this muscle is very invariable. Henle, p. 292.

Peroneus brev. in CHIMP. resembled that in man in its origin, but was stronger, and had a second tendon running along the 5th metatarsal connected by fibrous tissue with that bone, and fusing with tendon of Ext. l. d. and lumbricalis. This second insertion is not uncommon. In AN. as in man, but rose from the middle 1-3rd instead of the lower half of the Fibula.

Peroneus tertius absent in CHIMP.[1] In AN. it differed considerably from that in man. On both sides it rose from nearly the middle one-third of the Fibula enclosed in the P. br. Its tendon passed through the annular astragalo-calcaneal ligament with that of the P. br. (the Per. longus being in a separate channel). Its tendon fused with the extensor tendon of the little toe. This will be seen to be really a Peroneus quinti.

Extensor longus digitorum in both as in man[2].

Extensor proprius hallucis in CHIMP. as in man, but more powerfully adapted for abduction by passing under another ligament, besides the annular ligament, which extended from the tuberosity of the Scaphoid to the base of the inner metatarsal bones, and which gave passage also to the two tendons of the Tib. ant.[3] In AN. it rose from the upper two-thirds of the Fibula and interosseous membrane, but otherwise as in man.

Tibialis anticus in CHIMP. was, as is often the case, double, and the internal and larger tendon inserted into the Ento-cuneiform bone was separate throughout from the external and smaller tendon, which was inserted into the base of the metatarsal bone of the Hallux. In AN. it rose only from the upper half of the Tibia. It showed a tendency to become split, and we must remember that this was a young animal.

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[1] Macalister says it is never present in Quadrumana, "the so-called Peroneus tertius of Wyman, in the Howling monkey, being a Peroneus quinti;" Rolleston, however, found it in a CHIMP. Church mentions it in the Inuus nemestrinus and Cebus, and I found it in AN. on both sides; but in all the three latter at least it did not pass together with the tendon of the Ex. l. d., but with that of the P. br. Again, it was not inserted into the base of the fifth Metatarsal, but fused with the tendon of the Ext. l. d. opposite the Metatarso-phalangeal articulation, just as did the accessory tendon which I found to the Peroneus brevis (see above). In the Cebus it perforated the tendon of the Peroneus brevis opposite the Cuboid bone. Does not this perforation in the Cebus of the P. br. tendon, together with the second tendon which I found to the Peroneus brevis in CHIMP., go to show that the so-called P. tertius of Quadrumana is really a divarication of the P. br.? Wood mentions a "Peroneus quinti" as a human anomaly.

[2] The tendon, after passing under the anterior annular ligament, passed through a separate sheath springing from the base of the Calçaneum, and again inserted close to its origin, running upwards and inwards; from the superficial end of this sheath a small slip ran inwards to join the annular ligament over the internal malleolus. I can find no description of this ligament in any of the books, but I found it in AN. and CH. By its means the tendon was held just distally to the external malleolus. It is not found in man.

[3] This ligament is mentioned by Duvernoy in the Gorilla, but he says that the tendon follows the line of the metatarsal and first phalanx of the thumb, which was not the case in my CHIMP. It is not mentioned by Vrolik, Macalister, or Church, nor can I find any mention of it in CHIMP. It was present in AN.—Henle mentions that in man this muscle is occasionally double.

Extensor brevis digitorum in CHIMP. was as in man, except that it rose partly from the special sheath from the Calcaneum, transmitting the tendons of the Extensor l. d. The hallucal division was not separate, as has frequently been found by others to be the case. In AN. it was as in man, except that the tendon to the Hallux and next toe were given off by a common muscular belly, and the inner side of the muscular belly for the middle toe was attached by fascia to the inner side of the metatarsal of that toe, besides its insertion into the tendon of the common Extensor. A small muscle rose from the Calcaneum at its neck, and was inserted into the inner side of the base of the metatarsal bone of the great toe, together with one of the tendons of the Tib. ant. It exhibited a variability, which we found to obtain in the muscles of the hand, being absent in an adult AN., specially examined. It would seem to be a reduplication of the Ext. br. d., such as we have noticed in other muscles, *e.g.* Abd. p., Fl. br. 5ti (in the hand), and Iliacus and Psoas in the lower limb.

Abductor hallucis in CHIMP. as in man. Duvernoy found it so in the Gorilla[1]. In AN. it was different from that in man, and different on the two feet. On the left foot the proximal head rose with part of the Fl. br. d. and Abd. 5ti from the under surface of the Calcaneum, and joined the distal part of the second head (as was the case in the second head of the Fl. br. d.). The second head rose by two fascicles, one from the internal, one from the external side of the Scaphoid bone; these joined the tendon of the first head, and the common tendon was inserted into the external side of the base of the first phalanx of the great toe. In the right foot the second head rose not from the Scaphoid bone, but from the deep fascia opposite it, and a third head was added, also from the deep fascia opposite the tarso-metatarsal articulation.

Flexor brevis hallucis in CHIMP. was very different from that in man. Its *inner head* rose from several origins, principally from the Ecto-cuneiform bone, just where the second tendon of the Tib. p. was inserted. From this origin the internal portion (a) ran and fused with the lowest ¾ in. of the tendon of the Abductor. This fusion is found in man and in the Gorilla and Orang. The next portion (β) was inserted into the internal sesamoid bone. An underlying portion (γ) rose from the Ento-cuneiform, and was inserted with the last portion (β). Rolleston found the inner head prolonged by a tendinous expansion to the distal phalanx. The *outer head*, being that portion eventually inserted on the outer side of the tendon of the Flexor longus hallucis, was thus arranged: the most internal portion (a) rose together with portions a and β of the inner head from the Ecto-cuneiform bone, and, crossing under the tendon of the

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[1] In the Cebus and Inuus nemestrinus it had two distinct heads, one from the Calcaneum, the other from the plantar fascia. In the Orang it was inserted into the metatarsal as well as into the first phalanx. Vrolik describes two origins in CHIMP., one from the Ento-cuneiform, but also says it is as in man; this second origin is probably part of the Flexor brevis, the fibres of which as in man fuse with the tendon of the Abductor hallucis.

Fl. l. h., was inserted into the external sesamoid bone, as is the case in man. The next portion (β), having a similar origin and course, but larger, was inserted into the outer edge of the external sesamoid bone, fusing at its insertion with some of the adjacent fibres of the Abd. h., which fusion is also seen in man. The deepest portion (γ), consisting of 3 fascicles, rose from the Ento-cuneiform with portion γ of the inner head, and from the external side of the metatarsal of the Hallux in its whole length, and was inserted principally into the middle of the external sesamoid bone between the insertions of portions α and β; part however fused with portion β, and was inserted with it, and part fused directly with some adjacent fibres of the Adductor, and was inserted into the external edge of the external sesamoid bone[1]. In AN. it rose by two distinct heads: the inner from the internal Cuneiform bone, with one of the palmar Interossei, was inserted into the internal sesamoid bone, and into the base of the first phalanx of the Hallux; the outer rose along the line of the middle metatarsal bone, from the deep plantar ligament and sheath of the tendon of the Flexor longus hallucis going to the Hallux, and from a tendinous band of origin of the Interossei in that region. It was inserted into the external sesamoid bone, and the base of the first phalanx of the Hallux in common with the insertion of the Add. h. The identity of this muscle was proved by (1) its insertion, (2) its action, (3) its relation to the tendon of the Fl. l. h., which separated its two halves.

Adductor hallucis in CHIMP. was much larger than in man. Its principal origin was from the middle metatarsal in its whole length, and from an intermuscular septum between that and the fourth metatarsal. Its anterior and most transverse fascicle also rose from the distal end of the second as well as middle metatarsal, and its posterior or interior fascicle rose largely from the sheath of the Per. l., and the superficial and internal aspects of the base of the second metatarsal. It was easily separable into many fascicles, and might have been described as several muscles. Its general appearance was much more that of an Add. p. than of an Add. h., and it was stronger than the Add. p. It was inserted into the external side of the distal end of the metatarsal of the Hallux, some of its fibres fusing as in man with the adjacent part of the external head of the Fl. br.[1] In AN. it rose from the fascia and intermuscular septum between the metatarsals of the second and middle toes along rather more than their distal half; from a fascia, giving origin also to the plantar Interossei (thus showing its nature as an Interosseus), and to the external head of the Flexor brevis hallucis; also from the whole of the plantar surface of the base of the first phalanx of the second toe. It was inserted with the adjacent outer head of the Fl. br. h. into the outer side of the base of the first phalanx of the great toe. Its origin thus differed widely from that in man.

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[1] This last portion is called by Henle "*Interosseus volaris primus.*" All the deep portions in the CHIMP. also took origin from the sheath of the Per. l. All the superficial factors of both heads also had origin from the sheath of the tendon of the Flexor longus hallucis. Vrolik describes the muscle as rising from the Ento-cuneiform, and forming a thin muscular fascicle. In the Gorilla and Orang Duvernoy describes the whole muscle as rising from the Scaphoid and Ento-cuneiform. In the Orang Church found it rising from the Ento-cuneiform and plantar fascia, the external portion being inserted into the first phalanx, the internal into the metatarsal. In the Inuus nemestrinus the interior belly rose from the Ecto-cuneiform, and was inserted into the external sesamoid bone.

The whole muscle was supplied by the internal plantar division of the posterior tibial nerve. I could find no twig given from the deep branch of the external plantar to the external head, as sometimes in man (and as the analogy of the deep branch of the ulnar nerve in the hand would lead one to expect); that branch seeming to lie at a deeper level also than this muscle.

Abductor minimi digiti in CHIMP. was large, rising from the whole of the anterior and plantar edge of the tuber Calcis, and from the plantar fascia. Its external portion was inserted into the base of the 5th metatarsal. The next portion was inserted by a very delicate tendon into the external side of the base of the proximal phalanx of the little finger. The internal and main portion, which exhibited a penniform arrangement (a tendon which diminished from the origin of the muscle downwards, and disappeared before the insertion, lying on the middle of its plantar surface), developed one larger and two smaller tendons opposite the metatarso-phalangeal articulation, while other fibres were continued to the very insertion. These middle and internal portions were inserted just internally to the first[2]. In AN. it was as in man, and by its extensive connection with plantar fascia would give it tension and also flex the three exterior toes, owing to the fusion of the plantar fascia with the tendons of the Fl. br. d. of those toes. In an adult AN. there was also another muscle rising externally to it, and inserted into the base of the metatarsal of the little toe.

Flexor brevis minimi digiti in CHIMP., absent in Rolleston's CHIMP., rose as in man. Its origin was complicated, by being shared by the palmar Interosseus of the little toe, and also by a muscle which certainly fulfilled the requirements of an Opponens. In AN.

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[1] Duvernoy, in the Gorilla, describes it as two muscles, "adducteur oblique" and "adducteur transverse," according to the direction of the fibres. But no interval, such as that drawn by Duvernoy (Pl. x.) in the Gorilla, could be seen in my CHIMP., though its most transverse fascicle could be divided from the rest, as could several other fascicles. Vrolik does the same, and says that the oblique portion comes from the Cuboid, the transverse from the fifth metatarsal. I could find neither origin. He says also that it consists in man of the same portions. Church, in the Orang, found a fascicle rising from a ligament "stretched from the head of the third digit to be inserted into the distal end of the metatarsal and proximal end of the first phalanx of the second," and inserted into nearly the whole length of the metatarsal of the Hallux. Cuvier also calls this portion "adducteur transverse."

[2] It is curious that the insertion into the base of the 5th metatarsal (that of the external portion) is correlated with the absence of the so-called Peroneus tertius in CHIMP. and Cebus (Church, p. 17); but in the Inuus nemestrinus this insertion coexists with the Peroneus tertius. In CHIMP. it is weak, however, perhaps owing to the additional Extensor tendon given by the Per. br., and fusing with the Extensor tendon of the little toe. Vrolik found this muscle inserted into the second phalanx by a very fine tendon. Henle (p. 300, and Fig. 150, p. 296 a b q') describes an insertion into the tuberosity of the metatarsal as normal in man.

it rose from the base of the 5th metatarsal bone, and was inserted into the outer sesamoid bone and fibular side of the base of the first phalanx of the little toe. It was obviously an Interosseus.

Opponens minimi digiti in CHIMP. rose in common with the preceding, and with the palmar Interosseus of the little toe, and was inserted into the external and plantar surfaces of the 5th metatarsal in its whole length[1].

Transversalis pedis was wanting in CHIMP. as a separate muscle, as in the Orang, Cebus and Inuus nemestrinus, and occasionally in man; but was represented by the transverse portion of the Adductor hallucis.

Interossei in CHIMP. were of the same number as in man, but abducted and adducted relatively to the middle digit as in the *hand* of man and CHIMP., not relatively to the 2nd (index) digit as in the *foot* of man[2]. The first *dorsal* was much the largest, and had a broad origin from the base of met. I. as well from the side of met. I. like the Abd. indicis in hand.

In AN. the *Dorsal Interossei* were seven, and were inserted in the same manner as the plantar Interossei, and as in man. The internal (first and second) arose from the base of the metatarsal of the second toe, and were inserted one on each side of the second (index) toe. The third rose from the base of the metatarsal of the second (index) and middle toes, and was inserted into the internal (tibial) side of the middle toe. The fourth rose from the bases of the third and fourth metatarsals and was inserted into the external (fibular) side of the middle toe. The fifth rose with the fourth, but principally from the fourth metatarsal, and was inserted into the internal (tibial) side of the fourth toe. The sixth rose from the bases of the fourth and fifth metatarsals, and was inserted into the external (fibular) side of the fourth toe. The seventh rose from the base of the fifth metatarsal with the Flexor brevis minimi digiti, and was inserted into the internal (tibial) side of the fifth (little) toe. The dorsal Interossei alternately adducted and abducted from the middle toe.

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[1] I can find no description of this muscle in any of the anthropoid apes, but Henle and Huxley describe it as normal in man. It was found in a CHIMP. by Rolleston. This muscle is described and figured by Dr Halford in the Macaque. He also describes a similar muscle in the Hallux, and says that "Professor Huxley has not shown that Table IV. does not apply to the foot of the Gorilla, CHIMP., etc." Now, so far as CHIMP. is concerned, I can answer that no muscle was *inserted* into the length of the metatarsal of its Hallux, though I can confirm Dr Halford's conjecture as to the presence of a similar muscle in the fifth metatarsal, as described by Huxley and Henle in man. Part of the Flexor brevis hallucis *rose* from the whole length of the *outer* side of the first metatarsal, as I have described.

[2] Duvernoy, who makes this comparison *à propos* of the Gorilla, refers it to the prepotence of the middle digit in the hand and foot of apes, and the second digit of the foot of man, as indicated by the superior length. This was also the case in the Macaque. The differences entailed by the point of abduction and adduction being the middle toe in the Anthropoid apes, the second in man, are as follows:—the middle toe in the Anthropoid apes, the Index in man has two dorsal (abductors), no plantar Interossei (adductors). The adaptation of the same general plan, the dorsal being abductors, the plantar adductors, is highly interesting.

Table of *Dorsal* Interossei in AN.

Adductors which were also partial flexors.
2nd adducted 2nd (index) toe.
5th adducted 4th toe.
7th adducted 5th (little) toe.

Abductors.
1st abducted 2nd (index) toe.
3rd abducted 3rd (middle) toe towards Tibia.
4th abducted 3rd (middle) toe towards Fibula.
6th abducted 4th toe.

The 4th and 6th were also partial flexors.

In AN. the *Plantar* Interossei were three adducting to middle toe. They all rose from a common origin, viz. from the base of the middle met., and from a ligament stretched across the plantar space[1].

The external Plantar Interosseus ran to the base of the first phalanx and extensor tendon of the 5th toe, both on the tibial side. The second and first arose by a common muscular slip, and afterwards divided and were inserted each by a similar double insertion, the third on the tibial side of the fourth toe, the second on the fibular side of the second toe. They thus all adducted their toes towards the middle toe.

In both feet a small slip of muscle ran from the interior (tibial) side of the first (internal) Plantar Interosseus (rising from the intermuscular septum between the dorsal and Plantar Interossei), and was inserted into the distal part of met. III. This extra muscle points to the prepotence of the middle toe, as indicated also by its length. We find the same prepotence in CHIMP., where the adduction and abduction are to and from this toe instead of the second, as in man[2].

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[1] This is mentioned by Church in the Inuus nemestrinus and Cebus, and he does not seem to consider these muscles as Interossei. It is, however, at least significant that they all adducted towards the middle toe which, as we have seen, is the prepotent digit in the foot of apes. He found the same arrangement in the hand.

[2] Though these two layers were distinct, and one lay more dorsally than the other, still, as Church remarks of the Inuus nemestrinus, there were no dorsal Interossei, as none had a dorsal origin, and also, but for the set which I have called plantar (as being more plantar than the other, and lying superficially to it), and which Church does not seem to consider Interossei, his account of them in the Inuus nemestrinus would tally with mine in AN. Moreover, the real nature of the Fl. br. 5^1 appears, for it is evidently an Interosseus.

Duvernoy remarks that in the Gorilla, as I also found in CHIMP., the dorsal Interossei are not so dorsally placed as in man. Moreover, this fact was plainly set forth in the hand of my CHIMP., in which parts of the dorsal Interossei were so far divaricated palmarly, as to be positively palmarly, and not at all dorsally, placed. In the lower monkeys, as Cebus, Inuus nemestrinus and in AN., there are really no true dorsal Interossei, but two layers of Plantar, the more dorsally lying of which we may take, if we please, to represent the dorsal Interossei. The more plantarly placed resemble the Interossei of the Carnivora, as Church remarks. We therefore have an ascending series, from that case where the dorsal Interossei are plantarly placed (represented by the Cebus and AN., the more plantarly placed resembling those of the Carnivora), to

Abdominal Muscles.

Rectus abdominis in CHIMP. powerful, had two origins, as in man. The posterior wall of the sheath was founded by the aponeurosis of Transversalis only, the anterior by those of the external and internal oblique, thus differing from the arrangement in man. It was marked by four "inscriptiones tendineæ" (as in Vrolik's) which went quite through the muscle to the sheath.

In AN. it became continuous with a fascia interposed between it and the inner layer of the Pectoral opposite the fifth rib, and was attached, as in man, to the cartilages of the fifth, sixth and seventh ribs.

Pyramidalis in both was absent as in Vrolik's specimen.

External Oblique in CHIMP. rose by seven digitations from ribs 5 to 11 inclusive, the two lowest interdigitating with Lat. d., the rest with Ser. m. It was inserted into the ant. sup. iliac spine for half an inch only, into Poupart's ligament and the linea semilunaris. Its fibres ended below at the level of one inch below the anterior superior iliac spine, and mesially opposite the line of the Rectus. In AN. its first upper digitations were received not between those of the Ser. m., which failed to reach it, but of that special development of the Intercostals which has been already noticed.

Internal Oblique in CHIMP. resembled that in man. In AN. it did not reach the last rib.

Transversalis in both nearly as in man. The Fascia transversalis in CHIMP. was better developed than in man, in correlation with the increased strain on the abdominal muscles.

Nerves.

The factors given according to Quain, and Flower's Plates.

The innervation of the muscles closely resembled that in man, and did not call for remark except in the following particulars.

Anterior Thoracic in CHIMP., which supplied both Pectorals, seemed to receive supply from all the factors of the Brachial flexus, not only from C. V., C. VI., and C. VII.

Nerve to the Subclavius in CHIMP. had no communication with the Phrenic.

In CHIMP. the *Scalenus anticus* was supplied by C. VIII., instead of C. IV.

Phrenic nerve was formed in CHIMP. by C. IV. and V.; in AN. by C. IV. No connection could be found with the sympathetic in either.

Middle cervical Ganglion was fused with the 3rd in both.

Third cervical Ganglion in both was placed as in man at the root of the neck in an angle enclosed by the subclavian and vertebral arteries, which it more or less surrounded with plexuses. It sent

the anthropoid apes, where these are more dorsal, and thus to man, where they are more dorsal still. This dorsa migration of Interossei is very interesting.

twigs in company with the vertebral artery into the vertebral canal in the 7th cervical vertebra, another to join the 8th cervical nerve, another to join the recurrent Laryngeal nerve.

Circumflex nerve in both was formed of C. V, VI, VII, instead of by C. V, VI, VII, and VIII.

Posterior Thoracic nerve (external respiratory of Bell), was formed in CHIMP. by C. V. and VI. as in man. In AN. by C. VI., and VII.; but the 5th cervical nerve, which supplied the Rhomboideus major, gave twigs to the serratus magnus, which thus received its supply from C. V. and VI (also as stated above from C. VII) though in a different manner from that in man.

Intercosto-humeral in AN., unlike its representative in man and CHIMP., pierced the lower part of the Scalenus post., which was inserted in the 3rd and 4th ribs and not into the 2nd.

Nerve to the Levator anguli Scapulæ in CHIMP. was C. IV, not C. III.

Nerve to Rhomboideus minor was C. III. in AN., C. V. in CHIMP. as in man.

Supra-scapular in CHIMP., formed by C. V. alone instead of C. V. and C. VI.; nerve to *Teres major* in CHIMP., was from the Subscapular, but from the circumflex in AN.; and this latter arrangement has been noticed as an abnormality in the human subject by Prof. Turner[1].

Median in both passed under instead of superficial to the Brachial artery in the upper arm[2]. It communicated by its main branch with the ulnar nerve in CHIMP.[3] but not in AN. at about one-third of the distance down the forearm, and supplied the fingers simultaneously, and not from 2 main divisions. There was no supra-condyloid foramen.

Ulnar nerve in CHIMP. was small till it had received its factor from the median, when it doubled its size. It received a factor from the branch of the musculo-spiral nerve that supplied the Dorso-Epitrochlien, after which it gave some twigs to the inner head of the Triceps as it passed it, which possibly are derived from the branch of the musculo-spiral joint membrane.

Musculo-cutaneus in CHIMP. passed through a cellular interval in the coraco-brachialis, much more pronounced than in man. In AN. it did not pierce the Coraco-brachialis but passed quite beneath it (dividing it from the Biceps), and not superficial to it, as Wood[4] says is always the case in the 1st human variety, with which this arrangement otherwise corresponded.

Gangliform enlargements over the back of the carpus, at the end of the posterior Interosseous nerve, and on the branch of the

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[1] *Nat. Hist. Rev.* Oct. 1864, p. 615.

[2] Professor Turner has noticed a similar arrangement several times in the human subject; and Prof. Humphry informs me that its occurrence is almost always associated with some abnormal disposition of one or other of the main arterial trunks of the limb, which is a point of some practical as well as morphological importance.

[3] I have just met with an example of this in a human subject.

[4] *Camb. Journ. of Anat. and Phys.* 1867, p. 45.

Circumflex going to the Teres minor were present in CHIMP. as in man. In AN. they could not be distinguished.

Flexor profundus digitorum in CHIMP. was supplied by the anterior interosseous as well as by the main trunk of median and the ulnar.

Flexor longus pollicis in CHIMP. was supplied from the main trunk of the Median as well as from its anterior interosseous branch.

The general arrangement of the nerves of the lower limb and Lumbar and sacral plexuses was in CHIMP. very similar to that in man, but very different in composition, which was perhaps due to the fact that there were 13 instead of 12 dorsal vertebræ. The differences in composition will be more readily seen by the following Table.

MAN	CHIMP.
Ilio-Hypogastric, and Ilio-Inguinal, L. I.	D. XIII.
Genito[1]-crural, L. I. II.	D. XIII.
External cutaneous, L. II. III.	D. XIII. L. I.
Obturator, L. III. IV.	D. XIII. L. I. II.
Anterior crural, L. II. III. IV.	D. XIII. L. I. II. III.
Superior gluteal, L. IV. V.; S. I.	L. III. IV.; S. I.
Sacral plexus, L. IV. V.; S. I. II. III. IV.	L. I. II. III. IV.; S. I. II.
Small sciatic, L. IV. V.; S. I. II. III. IV.	L. III. IV.; S. I.
Great sciatic, see Sacral plexus.	

Psoas parvus in CHIMP. was supplied by D. XIII. instead of L. II. In AN. by L. II. *Psoas magnus* by D. XIII., and anterior crural in CHIMP. instead of by L. II. In AN. the superior part (see description) by the ant. crural, the inferior by L. III.

Pyriformis, in AN. but not CHIMP. by the Superior gluteal, not as in man from the 2nd Sacral n. *Obturator int.* in CHIMP. supplied as in man from the sacral plexus, but the arrangement was different; for while in man one twig rising separately from the plexus supplies it; a second, subsequently and separately arising, supplying the Gemellus superior; and a third, subsequently and separately rising, supplying the Gemellus inferior and Quadratus femoris; in CHIMP. one nerve was given off from the sacral plexus, which bifurcated and sent one division to the Ob. int; the other division then gave off a twig to the superior edge of the Gemellus sup., then dived below the conjoined tendon of the Ob. int. and Gemelli, supplying the Gemellus inf. and ended in the Quadratus femoris. (The two Obturator muscles are *never* supplied by the same nerve.) In AN. the same nerve supplied both Ob. int. and Gemel. inf.[2]

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[1] It also differed from that in man in lying externally instead of internally to the Psoas magnus.

[2] It will be observed in the arrangement of the nerves of the lower limb, as compared with that in man, that in many cases in which adjacent parts are supplied in man by nerves which are given off separately from a primary nerve-trunk, the same parts in these animals are supplied by nerves given off from a

Coccygeus in Chimp. by the 3rd, and not the 4th and 5th sacral nerves. The *great Sciatic* nerve in Chimp. did not divide till the Popliteal space, but in An. almost as soon as it issued from the Pelvis. The point of bifurcation varies widely in man[1]. In both its distribution varied somewhat from that in man. In An. the proximal end of the long head of the Biceps (the short head being absent) was supplied by the int. pop. n. the distal part by the ext. pop. The Semitendinosus and Semimembranosus were supplied together by a common branch of the great sciatic, instead of by separate branches, another instance of lowness of Integration. In Chimp. a separate trunk from the great Sciatic high up after a course of 4 in. gave off (1) a branch to the origin of the Semitendinosus; (2) a branch which supplied the upper third of the long head of the Biceps; (3) the remainder split into branches which supplied the proximal part of the Add. m., the mesial part of the Semitend. and Semimemb., and the separate external division of the Add. m. (noticed under that muscle). The short head of the Biceps was supplied by two twigs separately rising from the main trunk of the great Sciatic nerve, nearly opposite the middle of the thigh. Another instance of want of Integration; but it is curious that the anthropoid Chimp. furnishes a better instance of it than the low An.

Sartorius supplied in Chimp. by the main branch, and also (unlike that in man) in its lower part by the Internal Saphenous. *Pectineus* in Chimp. supplied by a somewhat large branch from the Ant. cr. n., and by a very small branch from the ob. In An. by Ant. cr. n. only. (In man the twig from the obturator is inconstant.)

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secondary branch together; that is to say, in man the primary nerve-trunk has absorbed the secondary trunks into itself. This is a good instance of the advance in "Integration" in man, as compared with animals less highly organised.

[1] Quain, Vol. II. p. 675. Turner (*Nat. Hist. Rev.* Oct. 1864, p. 616) says that such early duplicity, when it occurs in man, almost always coexists with duplicity of the Pyriformis.

PARTIAL DEFICIENCY OF THE TENDON OF THE LONG FLEXOR OF THE THUMB. By W. W. Wagstaffe, B.A., F.R.C.S., *Lecturer on Anatomy at St Thomas's Hospital.*

Peculiarities in the arrangement of the extensor tendons to the fingers are of common occurrence, but it is rare to find any great deviation from the usual plan of arrangement in the flexor tendons. I am, therefore, led to record an instance of abnormality in the long flexor tendon of the thumb, which came under my notice in the dissecting room at St Thomas's Hospital early in the beginning of last year.

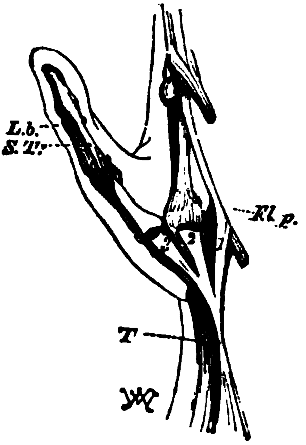
During the usual demonstrations my attention was called to what was thought to be a case of deficiency of the long flexor tendon of the thumb (left), and upon careful examination the following condition of parts was found. A muscle (T) occupying the usual position of the flexor longus pollicis arose from the radius and interosseous membrane, and its tendon passed downwards in its usual position under the anterior annular ligament and the superficial flexor tendons. Instead, however, of passing between the two heads of the flexor brevis to the thumb, the chief part of the tendon (1) joined the index tendon of the flexor profundus digitorum (Fl. p.): a second portion (2) spread out upon the carpus and attached itself to the ligaments covering the carpal bones in front: and a third part (3) left the tendon rather higher up, and was inserted by a well defined triangular expansion into the outer surface of the outer or superficial head of the flexor brevis pollicis.

On the thumb itself a well-marked tendon (ST) lay on the palmar surface of the first and second phalanges in the position usually occupied by the digital portion of the flexor longus pollicis tendon. This peculiar tendon was attached by two distinct slips to the head of the so-called metacarpal bone of the thumb. These two slips were connected one with each side of the head of the bone. From these proximal attachments it passed forwards, lying free upon the first phalanx, and was slightly spread out to be inserted as usual into the base of the ungual phalanx. A reflected portion representing the ligamentum breve (L. b.) was connected as usual with the capsule of the neighbouring joint and the head of the proximal phalanx.

The Nerves were also peculiar in the thumb. Two digital branches as usual came from the median, but about an inch from their origin they each presented enlargements—on the outer nerve two, on the inner one—in size about equal to a millet seed. Beyond these enlargements the outer nerve could be traced onwards to its ordinary distribution, but the inner nerve appeared atrophied and was lost in fibrous tissue opposite the middle of the first phalanx.

The arteries were smaller than usual.

In this case, therefore, we have a muscle arising like the flexor longus pollicis, but inserted into the deep flexor tendon to the index finger, and connected also with the fibrous structures about the wrist; we have a tendon resembling that of the flexor longus pollicis, but only stretching between the head of the metacarpal bone and the ungual phalanx; and associated with these muscular peculiarities about the thumb we have peculiarities in the appearance of the digital nerves and vessels.



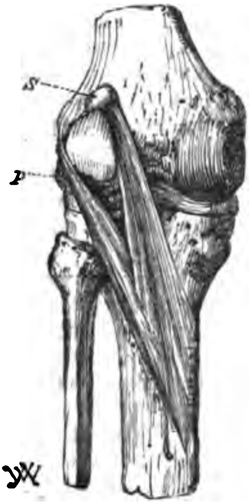
That these peculiarities were developmental appeared beyond doubt, for there was no evidence either in the existence of scar, or in the matting together of neighbouring tissues, that mechanical injury or disease had been the cause. It would seem that an error of development had occurred; that from some cause the intermediate portion had not been developed; that consequent upon this the free ends had attached themselves to neighbouring parts—one to the head of the metacarpal bone, the other to the deep flexor tendon for the index finger and the carpus. And the condition of the digital nerves and vessels would agree with, although it would not necessarily require, the supposition that these peculiarities were the result of faulty development.

It may be asked what movement was obtained in the thumb, and I can only judge by experiment made upon it after it came under my notice. No flexion of the ungual phalanx was obtained by traction upon muscles. The ordinary movements of the proximal phalanx were obtained. Traction upon the muscle which occupied the place of the flexor longus pollicis produced flexion of the index finger, with some flexion of the wrist. It did not seem that any means were provided for flexion of the tip of the thumb by connection between the flexor brevis and the slips of tendon lying alongside its insertion. It must be concluded, therefore, that the ungual phalanx of the thumb in this case was not capable of movement at the will of its owner; and as no history could be obtained of the old woman's habits, owing to her being an unclaimed subject, I am unable to give the historical evidence which might be interesting.

DESCRIPTION OF AN ACCESSORY MUSCLE IN CONNECTION WITH THE POPLITEUS. By W. W. WAGSTAFFE, B.A., F.R.C.S., *Lecturer on Anatomy at St Thomas's Hospital.*

In dissecting the popliteal space of the left leg of a subject last session, an unusual muscle was found in connection with the popliteus.

The outer head of the gastrocnemius possessed a rather large sesamoid (*S*) bone close to its attachment to the femur. From the inner side of this sesamoid bone arose a rather strong tendinous structure, distinct from the gastrocnemius proper, and soon expanding into a well-marked muscle, which passed downwards to the tibia. The fibres were directed inwards as well as downwards, and lay superficially to those of the popliteus (*P*), ultimately becoming attached to the inner edge of the tibia as far as the oblique line, and also blending with the fibres of the popliteus. The popliteal fascia



was spread over that portion of the muscle which was in contact with the popliteus.

It is worthy of note that the plantaris was absent, and that the general muscular development was not excessive; and also that no similar abnormality was found in the opposite limb.

I have searched without success for the record of any similar abnormality in the human subject, and I do not find in comparative myology much that will throw light on such a variation. I know of no instance in which the post-condyloid or gastrocnemial sesamoid bone gives origin to portion of the popliteus; but in the Anteater Professor Humphry describes the outer head of the gastrocnemius as arising from the popliteal sesamoid. (*Journ. of Anat.* IV. 59.)

The use of the muscle in the present instance was obvious. It acted as a flexor of the leg upon the thigh, and assisted slightly in rotating the tibia in the first movement of flexion.

UTERINE CONTRACTIONS DURING PREGNANCY.

Dr J. Braxton Hicks, F.R.S., read a paper at the Obstetrical Society of London, on 4 Oct., in which he pointed out a fact which he considered had not been noticed before; namely, that the uterus not only during the last month of pregnancy, but from at least the third month, contracted and relaxed frequently. These contractions occurred every 5 to 20 minutes generally, although sometimes the intervals were longer. They lasted about 3 or 4 minutes, but in the case of a diseased ovum the contractions were frequently longer, and sometimes almost continuous. They took place even in cases of vesicular mole (Hydatiniform degeneration of the Chorion). Dr Hicks had only in one case noticed the absence of these contractions, viz. in a case of Paraplegia, at least while it was under his observation for two months. When the uterus was retroverted in the early months of pregnancy the uterine body was more readily under observation and its state easily noticed. These contractions are not owing to the external irritation during examination, but as frequently as not the uterus is found upon first examination to be hard, and then to relax. After describing the physical state of the organ during these conditions, Dr Hicks alluded to the value of these contractions physiologically. He thought at least two advantages were derived from them: one to supplement the heart impulse in a part so far removed from its effects: the other to assist the ultimate disposition of the fœtus. After this he discussed at length the assistance to diagnosis these frequent contractions gave the practitioner.

ANOMALIES OF ARRANGEMENT. By D. Embleton, M.D.

Muscular.

The anomalies here given were observed in the Dissecting Room of the then Newcastle-upon-Tyne School of Medicine and Surgery, during the dissection of the body of a muscular sailor in 1842.

The *Biceps Flexor Cubiti* had, as is not very uncommon, three heads, two of which arose in the ordinary way, the third took its fleshy origin from the inner side of the humerus along the ridge extending upwards from the inner condyle between the contiguous edges of the Brachialis Anticus, and the Triceps Extensor, and in front of and below the insertion of the Coraco-brachialis. It was about two inches in length of origin, was thick, and resembled, except that it was smaller, the femoral head of the Biceps Flexor Cruris. It joined the common tendon of the muscle at the inner side and back part, at the bend of the elbow.

On both sides there was no distinct *Flexor brevis minimi Digiti.* The *Palmaris brevis* was very largely developed. The outer edge of the *Supinator Radii longus* just where the muscle ends in the tendon was inserted into the fascia of the arm covering the extensor muscles. The *Pronator teres* had no origin from the coronoid process of the ulna, arising only from the inner condyle of the humerus. The *Infraspinatus* and *Teres minor* were united as one muscle. The *Teres major* very thick and strong.

In the left arm there was no *Palmaris longus*, though in the right it was present and normal. The *Flexor Carpi radialis* and the *Flexor Carpi ulnaris* were both attached to the Palmar Fascia, the former more directly and more extensively than the latter, which however was more connected with the fascia than is usual when the Palmaris longus is present, but the *Flexor Carpi radialis* chiefly supplied the place of the *Palmaris longus.*

There were no *Pyramidales abdominis.* The *Psoas parvus* was absent from both sides. The Cremasters arose in the mode described by Gabriel, Fallopius, and even by Galen, long before M. Jules Cloquet had dissected them and claimed the discovery of their arrangement.

In the Perinæum were two *transversi* muscles on each side.

In the deep posterior region of each leg was an additional small muscle of an interesting character. It arose in each leg, fleshy, from about the inferior third of the posterior surface of the fibula, but not quite so far down as the malleolus externus; the fleshy fibres passed backwards to a slender tendon, forming a simple and short, but thick and strong penniform muscle. The slender tendon passed down towards the sole of the foot, between the inner ancle and the heel, behind the *Flexor Pollicis longus,* and therefore behind all the other parts lying in that region. In the sole it was found between the tendon of the *Flexor longus digitorum communis* and that of the *Flexor longus Pollicis,* where it divided into two slips, one being firmly attached to the innermost division of the former tendon, and the other to the outer side of the latter tendon. This muscle was therefore an assistant flexor of all the toes, aiding both the common flexor and the special flexor of the great toe, and supplanting the usual arrangement by which these two muscles are combined in action by a strong offset from the tendon of the latter passing to unite with the tendons of the former. (The muscle above described must be rather a rare anomaly, and I do not find it mentioned in any of the books to which I have access.) The *Flexor accessorius* was well developed. The *Peroneus tertius* ended in two small tendons which passed, the inner to near the base of the fourth metatarsal bone, the other to the ligament connecting the base of the fourth to that of the fifth metatarsal.

In another subject, the *Gemellus superior*, on the right side, was absent, the Obturator internus being stronger than usual, and to its tendon that of the Gemellus inferior was scarcely at all adherent.

ARTERIAL.

In Session 1845—46. In a boy of 17 years the arrangements at the arch of the aorta were as follows: there were only two primary branches from the arch, viz. the Brachio-cephalic and the left subclavian, the former immediately divided into two secondary branches, the Brachio-cephalic proper and the left common carotid, the latter, the left subclavian, pursued its usual course, whilst the left carotid crossed over directly to its proper position.

The heart was altogether higher placed in the thorax than usual, its apex pointing to the interval between the fourth and fifth ribs, near to the costal end of their cartilages. On the left side were two Ascending Pharyngeal Arteries; the superior thyroid was given off from the common carotid two or three lines below its bifurcation; the lingual and the facial came off by a common trunk, and there were two branches from the external carotid just above the bifurcation, to the pharynx. The posterior auris came from the external carotid. There were two renal arteries on each side.

NERVOUS.

In a fœtus dissected in 1840, the Chorda Tympani Nerve, after issuing from the fissure of Glaser, applied itself, not to the gustatory, but to the inferior dental nerve, and leaving it at a line or two above the orifice of the dental canal, passed on in the direction of the submaxillary gland, and before joining the submaxillary ganglion, sent a branch of communication to the gustatory nerve, and twigs to the submaxillary and sublingual glands.

May 27, 1871.

REPORT ON THE PROGRESS OF PHYSIOLOGY[1]. By T. LAUDER BRUNTON, M.D. D. Sc., *Joint Lecturer on Materia Medica and Therapeutics, St. Bartholomew's Hospital*, and DAVID FERRIER, M.A., M.D., *Demonstrator of Practical Physiology, King's College, London.*

Nervous System.

FUNCTION OF THE CEREBRAL PEDUNCLES.—In his experiments on this subject, Afanasieff (*Wien. Med. Wochensch.* pp. 137, 153, 169, and 185) divided one or both peduncles through a hole in the temporal bone. In consequence of the transitory irritation which the section produced, the animal immediately afterwards drew itself together, the head was inclined to that side on which the peduncle had been divided, the pupils became contracted especially on that side, and the arteries of the ears also contracted, but their contraction was more marked in the ear of the opposite side. In six seconds after the operation all the above-mentioned effects were succeeded by their opposites. The irritation also produced increased flow of tears and saliva, and twitchings of the extremities on the side opposite the section, all of which lasted for half an hour. Section of one peduncle between the pons and tuber cinereum produced paralysis of the muscles of the extremities on the opposite side, and of those of the back and neck on the same side. The amount of paralysis increased with time.

The character of the manège and pointing movements made by the animal after the operation changed through time, and in two or three weeks it was again able to run straight forward. A section opposite the tuber cinereum, or in front of it, produced paralysis of the muscles of the back and neck as well as of the extremities on the opposite side, shewing that the nerves from the dorsal and cervical muscles cross opposite the tuber, while those of the extremities cross lower down in the peduncle. Section of the peduncle causes complete paralysis of the oculo-motorius on the same side and imperfect paralysis of the facial nerve on the opposite side. It also produces diminished sensibility of the body and head, and contraction of the arteries, which lasts for 10 or 15 days, and is more marked in the ear on the same side as the section, than on the opposite one.

At the moment of section the blood-pressure is increased and the pulse slowed, in 30 or 40 minutes after it the temperature of the body becomes lowered from 1·5 to 2° C. Division of both peduncles destroys the power of voluntarily relaxing or tightening the sphincter ani as well as of relaxing the constrictor urethræ. It does not affect the movements of the bladder.

CENTRAL IRRADIATION OF THE IMPULSE OF THE WILL.—Nothnagel (*Arch. f. Psychiat. und Nervenkrank.* III. 214—218) describes a case of what he terms central irradiation of the impulse of the will. A patient, after an attack of typhus, suffered from a curious affection of the left leg and right arm. Only after great trouble and the lapse of several minutes could the patient flex the right arm when he wished. The biceps became hard and contracted, and at the same moment the triceps also contracted and offered strong resistance to the flexor muscles.

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[1] Physiological papers to be sent to Dr Brunton or Dr Ferrier, 23, Somerset Street, Portman Square, London, W.

[The Reports by Prof. Turner and Dr Fraser are unavoidably postponed till next number.]

These phenomena only occurred on slow or moderately quick movements. The flexors and extensors of the left leg were similarly affected, but to a less extent. From the fact that these anomalies could not be induced by mechanical irritation, and that the contraction of both muscles began at the same time, and also from the circumstance that when one of the muscles was irritated directly, it contracted, while its antagonist remained at rest, the author concludes that this was an example of central perversion of innervation, not of reflex origin.

IRRITABILITY OF THE CENTRIPETAL FIBRES IN THE SPINAL CORD. —Ludwig and Dittmar (*Ludwig's Arbeiten*, 1870, p. 4) use the rise of blood-pressure which occurs in curarized animals when a sensory nerve is irritated, as a test of the conduction of sensory impressions to the brain, and consider it to be a much more delicate index than the movements or struggles of the animal. They find that the blood-pressure rises in proportion to the amount of irritation, when other disturbing factors, such as exhaustion or changes in the respiration, or pulse rate, &c. are excluded, and each irritation has the same duration. The dura mater is one of the most sensitive parts in the body, and the mere opening of its sac causes the blood-pressure to rise as much as the operation of separating the posterior from the anterior columns of the cord. When the cord was exposed and divided, and the nerve-roots cut or torn, a slight irritation of the central end lasting for several seconds, such as rubbing it with a blunt needle, or the application of a very weak galvanic current, caused a considerable rise in pressure. A 5 per cent. solution of caustic potash also caused a rise. Momentary irritations, mechanical, chemical or electrical, however powerful, had no effect; caustic potash having no action, and sparks from an induction coil causing no rise even when repeated every three seconds. When the cord was divided into anterior and posterior halves irritation of both caused a rise, but that produced by irritation of the anterior half was the greater, perhaps from the anterior roots or dura mater being also irritated. When the cord was raised from its bed and divided into parts irritation of the anterior columns, or of the grey substance, had no effect; irritation of the lateral columns caused a slight rise, and irritation of the posterior columns a rise of pressure.

Irritation of the peripheral stump of the cord caused a rise sometimes greater and sometimes less than the reflex rise, and, at the same time, a slowing of the pulse. The effect of irritation of the central stump of the cord was inconstant though quickening was often observed. The influence of the point irritated, or of the nature or strength of the irritation on the pulse, is not constant. For an explanation of this we must refer to the original. The rise of pressure occurs after the cerebrum has been separated from the medulla. This shews that it may take place without the animal feeling. When the cord was irritated after separation from the cerebrum no rise took place at first, but this was due to an accumulation of blood in the spinal canal, and when the blood was removed a rise occurred as before. Although irritation of a sensory nerve may cause reflex independently of sensation, there is no reason for believing that there are special vaso-excito-motor fibres distinct from sensory ones.

TIME REQUIRED TO COMMUNICATE IMPRESSIONS TO THE SENSORIUM, AND THE REVERSE.—As a means of measuring the time necessary for this, T. C. Mendenhall (*American Journal of Science and Arts*, 3rd Ser. II.), made use of an astronomical chronograph, which moved a slip of paper at the rate of 1½ inches per second. The seconds were marked on this by means of electricity. The person experimented on was seated before an opening at which a red or white card could be exhibited, and his finger rested on a knob which at the slightest pressure closed a current and produced a dark spot on the moving paper. This knob he was directed to press as soon as he saw the card appear at the opening. The exact instant at which it came before the opening was noted by electricity on the paper, and by measuring the distance between this point and that produced by pressure on the knob the time requisite for the impression to travel up to the sensorium and back through the motor nerves to the finger could be easily ascertained. By causing cards of different colour or shape to appear, and desiring the person to indicate their character, by pressing on one or other of two knobs, the time requisite for deciding between them was ascertained.

The time required to respond to the appearance of a white card

was	0·292	seconds.
... ... an electric spark	0·203	...
... ... a sound	0·138	...
... ... touch on the forehead	0·107	..
... ... touch on the hand	0·177	...
when required to decide between white and red	0·443	...
... ... a circle and a square	0·494	...
... ... the tones C and E	0·335	...
... ... C and C above	0·428	...

SENSORY PATHS IN THE SPINAL CORD.—Miescher, under Ludwig's direction (*Ludwig's Arbeiten*, 1870, p. 172), performed a series of experiments in order to determine what parts of the spinal cord have the power of conducting impressions. Like Dittmar, he used the rise of blood-pressure, which occurs on irritation of a sensory nerve, as an index of the conduction of the impression to the brain. The experiments were made by irritating the sciatic nerve and comparing the rise in blood-pressure which ensued before and after the division of parts of the spinal cord. The cord was reached by cutting out a part of the laminæ between two spinous processes. In order to limit the extent of the section more accurately, a small knife 8 mm. long and 2 mm. broad, was driven with its flat side parallel to the longitudinal fibres of the cord quite through it, till it became firmly fixed in the bone in front. The part of the cord lying on one or other side of it was thus completely protected, so that either part could be entirely destroyed without fear of injuring the other. When one or both lateral columns were left and the rest of the cord completely divided, irritation of the sciatic nerve caused the blood-pressure to rise just as before. The irritation in this case was not conducted by means of small portions of grey matter still adhering to the column, since the result was quite as well marked when the column was absolutely free from them. When both lateral columns were cut there was no reaction, although the rest of the cord remained intact.

This shews that the impressions on the sciatic nerve which produce reflex rise of blood-pressure are conducted chiefly, if not entirely, by the white lateral columns of the cord. When one lateral column was preserved, rise of pressure followed irritation of either sciatic, but it was higher when the opposite nerve was irritated, shewing that in that part of the cord which lies between the last thoracic and third lumber vertebra, impressions from the left sciatic are chiefly conducted by the right lateral column, and to a less extent also in the left, and *vice versa*. The crossing of the conducting paths takes place gradually, and those which enter the cord low down run in its most external part, while those which enter higher up run nearer to the middle line. No hyper-æsthesia was observed in the hinder extremities after partial section of the cord.

CHOREIFORM MOVEMENTS IN DOGS, AND ACTION OF ELECTRICITY ON REFLEX MOVEMENTS.—Legros and Onimus (*Journal de l'Anat. et Phys.*, 1870, p. 403) find that the choreiform movements in dogs vary in character and are generally not coincident with the cardiac pulsations. They have their cause in the grey substance of the spinal cord, but may be modified by the action of the brain. They are lessened by division of the posterior roots of spinal nerves. Their disappearance during sleep shews that the spinal cord sleeps as well as the brain. They are lessened by chloral. The cord presents no pathological appearances except slight congestion. A constant electrical current passing upwards through the cord causes irritation, increases reflex action, and does not remove the tetanus produced by strychnia and picrotoxin. A current passing downwards produces inhibition of reflex action and at once stops the tetanus produced by these poisons. The choreiform movements are increased by an ascending and diminished by a descending current. When the current is opened an opposite effect is produced.

INFLUENCE OF THE POSTERIOR ROOTS OF SPINAL NERVES ON THE IRRITABILITY OF THE ANTERIOR ROOTS.—Steinmann and Cyon (*Bull. de l'Acad. imp. des Sciences de St. Petersbourg*, VII. Dec. 1870) find that when the posterior roots of spinal nerves in frogs are quickly divided without pain to the animal, irritation of the anterior roots produces a weaker contraction of the muscles than before. If pain be produced by the division, the contractions immediately after it are stronger than before, and then they become weaker. This is due to the direct irritation of the anterior root being strengthened by that produced by the pain. After the posterior roots were divided the muscles became extended more quickly and to a greater extent after a contraction than when the nerves were intact. If a weight were attached to the muscle, it became longer when the posterior roots were divided. They regard this as a proof that the muscles are naturally in a state of slight tonic contraction, due to excitations conveyed to their motor nerves through the posterior roots.

TROPHIC LESIONS.—Fischer (*Berlin. Klin. Wochenschr.* 1871, No. 13) describes the phenomena, viz. œdema, impaired nutrition of the nails, skin eruptions, and lastly, neuroparalytic ulcerations of the fingers and toes, which result on lesions of the nerves of the extremities. The temperature of the paralysed parts is at first higher, and afterwards lower than normal; generally there is much more copious perspiration. The author rejects the idea that these phenomena are merely traumatic and due to loss of sensibility. He finds that the sensibility may be quite normal. He agrees with Samuel in attributing the effects to paralysis of special trophic nerves.

Schiefferdecker (*Berlin. Klin. Wochenschr.* 1871, No. 14) records several cases of trophic disturbances following lesions of nerves. The phenomena were atrophy of the muscles, thickening of the skin, desquamation, irregular growth of hair and nails, and increased perspiration. Some of these phenomena he thinks are undoubtedly due to paralysis of special trophic nerves.

ELECTRIC STIMULATION OF NERVE.—J. König (*Wien. Acad. Sitzber.* LXII. 2 Abth. 537—46) has put Dubois Reymond's law of nerve stimulation to the test of fresh experiments. As a stimulant he employed the irritation caused by closure of the descending current. From his experiments it appeared that no contraction occurs when the duration of the current is very short, and that from the minimum, increased duration of the current causes the height of contraction to rise at first rapidly and then more slowly, until, with a duration of the current from 0·025 – 0·018 sec., the curve blends with the asymptote which represents the height obtained by prolonged closure of the same current. Lamansky's view is thus confirmed, that the so-called super-maximum contractions arise from the summation of two stimuli. He agrees with Dubois, that for weak currents of short duration the excitation depends chiefly on the amount of variation in the intensity of the current from one moment to the other. In accordance with the observations of Brücke, it would appear that the electric current, in order to produce the molecular change corresponding to excitation of a nerve, must have a duration of at least 0·0015 sec. Even then the irritation does not occur instantaneously, but occupies a certain time with gradually diminishing intensity. The author gives a formula which includes these various factors. If the nerve is cooled down to 0°, a duration of the current of 0·02 sec. is necessary in order to produce irritation of the nerve, and at this temperature the differences in the amount of irritation seen at ordinary temperatures are no longer observed.

NEGATIVE OSCILLATION OF THE NERVE-CURRENT.—Schiff (*Pflüger's Archiv.* IV.) adduces further evidence in support of his view, that the negative oscillation which is observed when a nerve is irritated is dependent on an "irritation-current," and not on the natural current of the nerve when in the state of rest.

ELECTRO-MOTOR PROPERTIES OF EMBRYONIC NERVE AND MUSCLE.—Valentin (*Zeitschrift f. Biol.* VII. p. 105) finds that before the 8th or 10th day the nerves and muscles in the chick are not sufficiently differentiated to allow of a satisfactory examination. On the 11th day the muscles have the power of contraction, but both they and the nerves are far from being completely developed. Nevertheless, they both shew the same currents that they do in their perfect state, as well as the negative oscillation during action.

DEVELOPMENT OF HEAT IN NERVES AND NERVE-CENTRES.—Schiff (*Arch. de Phys. Norm. et Path.* II. III.) has investigated the question of development of heat in nerves and nerve-centres consequent on sensorial and sensory impressions. His experiments were made by means of a very delicate thermo-electric pile of antimony and bismuth. The development of heat in nerves was less marked the farther from the point of irritation. Schiff explains this by diminution of the irritation during transmission. In the case of the brain he found that during life there was a distinct development of heat in the hemispheres on the occurrence of a peripheric stimulus, such as pressure. The deviation of the needle indicated unequal development of heat in the hemispheres. The development of heat is greatest in the middle of the hemispheres.

Schiff (*Pflüger's Archiv.* IV.) irritated from the cord the sciatic nerves of both sides, one of which had been cut at its junction with the gastrocnemius muscle, and expected to find a development of heat in the cut nerve. He found, however, that there was no difference between the two, or even a development of heat rather in the uncut nerve. He offers no explanation of the phenomenon.

Bernstein, *Investigations on the Stimulation of Nerve and Muscle*, Heidelberg, 1871.

Wundt, *Mechanism of the Nerves and Nerve-centres*, Erlangen, 1871.

Eulenburg, *Diseases of the Nervous System considered Physiologically*, Berlin, 1871.

Vision.

TIME REQUISITE FOR VISUAL PERCEPTION.—Baxt (*Pflüger's Archiv.* IV. 325—36), under the direction of Helmholtz, has made some very interesting observations on the time required for a visual impression to affect consciousness, and on the extent of the percept in visual impressions of given duration.

The experiments of Helmholtz and Exner had shewn that when a number of black letters are printed on a white ground, one, or two, or more of these can be distinguished according to the duration of the retinal impression. These results form the starting point of Baxt's experiments. By an ingenious apparatus, the image of a number of black figures printed on a white ground could be allowed to fall on the retina for any fraction of a second, at the end of which time the impression was succeeded by a very much stronger stimulus. In this way could be estimated the time which simple impressions require in order to affect consciousness. For the time requisite for perception is that time after which a weaker impression can no longer be effaced by a stronger.

Within certain limits, it was found that the time requisite for the first impression was independent of the degree of illumination of the object. The experiments shewed that consciousness is able only gradually to elaborate a given impression, and that between the direct stimulus and the perception in consciousness one-twentieth of a second intervenes.

It appeared also, although the experiments could not be carried far, on account of the fatigue to the eye, that a very strong second stimulus is able to efface the first even after a longer interval. In regard to the extent of the percept, the results shewed that in all degrees of intensity of the impression a much longer time is necessary to perceive small objects (such as intervals of space) than large ones. Thus with a duration of the impression for 0·0005 second, and good illumination, large letters could be distinctly perceived, while smaller ones of the same form were very indistinct or quite imperceptible. Further experiments in reference to Fechner's psychophysical law, "that differences of illumination are more easily perceived the less the general degree of illumination," proved, that in proportion to the difference in the illumination of two different objects the time requisite for perception diminishes.

TIME NECESSARY FOR VISION. — Ogden N. Rood (*American Journal of Science and Art*, 3rd Ser. II. 159) finds that the letters on a printed page may be plainly seen, and if a polariscope be used, the cross and rings round the axes of crystals can be observed with all their peculiarities, and errors in the azimuth of the analyzing prism noticed by an electric spark, whose duration is only forty billionths of a second.

Subjective optical phenomena can also be produced, such as Loewe's rings, using cobalt glass, and the radiating structure of the lens perceived, if the light falls in a proper direction.

As the obliteration of micrometric lines in the experiment could only be produced by the retina retaining and combining a series of impressions whose joint duration is forty billionths of a second, a less time is sufficient for the production of each. If the number of views of lines presented to the eye be limited to ten, then four billionths of a second would be sufficient for each. Nor is this astonishing; for, assuming the undulatory theory to be true, in this short period two and a half millions of waves of light reach the eye.

SENSIBILITY OF THE EYE FOR COLOURS.—Lamansky (*Von Gräfe's Archiv.* XVII. I. 123, 4) finds that the sensitiveness of the eye is greatest for green, yellow and blue, and least for red. This agrees with previous experiments, and with the known facts that with faint illumination, blue is better seen than red, that the peripheric portions of the retina are entirely insensible to red, and that in commencing atrophy of the optic nerve, red colour-blindness first appears.

The time requisite for the perception of red is three times as much as that requisite for blue. The sensibility for white light is intermediate between that for green, yellow and blue on the one hand, and for violet, orange and red on the other.

SPECTRA OF MOTION.—Dvorak (*Wien. Acad. Sitzber.* 2 Abtheil. LXI. 257—262) seeks to explain the subjective sensations of motion which are observed when the eye has been fixed long on a moving object. Helmholtz explains them by unconscious movements of the eye, and brings them under vertiginous phenomena. Dvorak mentions several facts which, in his opinion, shew that the spectra are really local phenomena, and of the same nature as light and colour spectra.

ON RETINA CURRENTS. — Holmgren (*Upsala Läkareförenings Fordhandlingar*, 1871, abstract in *Centralblatt*, Nos. 27, 28, 1871) finds that the whole theory of currents between the optic nerve and retina has been based on the false conception that the retina is the mere transverse section of the optic nerve. The retina, instead of being the simple transverse section, is a complicated structure, and is at the same time the longitudinal and transverse section. In the unstimulated eye each point on the posterior surface of the eyeball is negative to any point of the cornea. The strongest current is produced when the centre of the cornea is joined with any point in a circle half way between the optic disc and the ora serrata. This circle he calls the electro-motor equator of the eye. In the cornea itself, and in the retina, there are currents according as the points are symmetrical or unsymmetrical to the centre or equator. The centre of the cornea is always positive to any other part, and the electro-motor equator negative to any point nearer the optic disc or ora serrata.

When the retina is stimulated by light an oscillation takes place in all vertebrates except fishes. In the frog the oscillation is positive. In all others it is negative, but positive when the light is withdrawn. The oscillation which occurs on contraction of the pupil is not to be confounded with the retinal currents, for on contraction of the pupil, i.e. the falling of light on the retina, the oscillation is positive, on dilatation, i.e. disappearance of light, the oscillation is negative, which is just the opposite of the retinal currents. Experiments with light of various colours proved the inactivity of the ultra-red rays; the strongest action is caused by the rays of the middle of the spectrum. The ultra-violet rays are still active. There is, therefore, an intimate relation between stimulation of the retina and oscillation of the current, the latter being "the objective signal of the subjective sensation."

MOVEMENTS OF THE EYEBALL. — Berlin (*Centralblatt*, No. 35, 1871) has made experiments in relation to certain movements of the eyeball observed by J. J. Müller and Donders on voluntarily opening or closing the eyelids. He determines the axis of rotation by a new method. The axis (drehpunkt) is constant for each horizontal plane, but on elevation of the plane of vision it lies more posteriorly, on lowering, on the other hand, more forwards. In voluntary forcible opening of the eye the eyeball projects, and on closure it again retreats. With the movement of the eyeball forwards there occurs also a movement downwards with a minimum shifting inwards. The synergic contraction of both oblique muscles and the levator palpebræ superioris is sufficient to account for all these movements. By movements of vision in a vertical plane the eyeball undergoes analogous changes of position. When the eye is directed from below upwards the globe projects from the orbit downwards and forwards, and *vice versâ* when the eye is directed from above downwards. Further, it was found that in almost all horizontal and vertical visual movements there occur movements of the eyeball out of the visual plane, of such a nature that whenever the oblique and the lev. palp. sup. take part in a movement, the eyeball changes its position in the line of traction of these muscles.

Hearing.

MOVEMENTS OF THE EAR.—Mach and Kessel (*Centralblatt*, No. 38, 1871) by means of a new method have observed that the membrane of the fenestra rotunda bulges outwards when the stapes swings inwards, that contraction of the internal muscles alters the excursions, and axes of rotation, of the ossicles, and that the excursions of the posterior segment of the membrana tympani in the living ear are much greater than those of the other parts of the membrane.

HYPERÆSTHESIA ACUSTICA.—Politzer (*Arch. für Ohrenheilk.* v. 206—12) communicates an interesting case bearing on the physiology of the acoustic nerve. A woman had become deaf after an attack of typhus. Neither noises nor musical notes of ordinary intensity were heard, nor even the vibrations of a tuning-fork communicated through the bones of the head. When the notes of a harmonium were conveyed to the ear by an ear-trumpet, it was found that there was no reaction when simple notes were sounded, but when the thirds of the higher notes of the scale were sounded the patient complained of an indescribable painful sensation in the ear and brain. In order to explain this, it must be supposed either that this is a reflex phenomenon, or that the auditory nerve, though chiefly a nerve of special sense, contains another class of fibres which are likewise capable of being stimulated by sounds, but instead of causing a sensation of sound convey a common sensation. Why these should be acted on only by combined notes remains unexplained.

Taste.

NERVES OF TASTE.—Lussana (*Gazz. Med. Ital. Prov. Venet.* XIII., *Centralblatt*, No. 15, 1871) brings forward a case from the clinique of Prof. Venzetti, which confirms the view that the lingualis is the only nerve of taste for the anterior part of the tongue. Most physiologists are agreed, that the fibres subservient to the sense of taste are not contained in the lingualis at its origin from the third division of the trigeminus. L. records two cases in which there was complete paralysis of all the three divisions of the trigeminus. Though the common sensibility of the tongue was entirely lost, the sense of taste was intact. On the other hand, there are numerous cases of paralysis of the facial nerve in which the sense of taste was lost in the fore part of the tongue on the paralysed side. Lussana brings forward three new cases of this kind. Hence it appears that the nerves of taste to the anterior part of the tongue are derived from the facial and join the lingualis through the chorda tympani. Schiff, on the other hand, has stated, that the special nerves of taste to this part of the tongue, though not contained in the lingualis at its origin, still are derived from the trigeminus. According to him they go through the second division of the fifth to the spheno-palatine ganglion, thence by the vidian nerve to the ganglion geniculatum of the facial, and so through the chorda to the lingualis. Lussana's cases overthrow this view.

Circulation.

GANGLIA OF THE HEART.—Schmiedeberg (*Ludwig's Arbeiten*, 1870, p. 41) has found that the vagus contains fibres which have a quickening effect, as well as others which slow the action of the heart. The latter are paralyzed by nicotin, the former are not. The inhibitory apparatus of the heart is not identical with the terminal filaments of the vagus in the heart, or with the motor ganglia, but is probably of a ganglionic nature and connected to the vagus by an intermediate structure. Nicotin paralyzes the filaments, or this intermediate structure, but not the inhibitory apparatus. Atropin paralyzes the inhibitory apparatus itself. The fibres which produce quickening probably act like the inhibitory ones through the medium of a ganglionic apparatus which is not identical with the motor ganglia of the heart. The stoppage of the heart which follows a cut, or the application of a ligature between the auriculo-ventricular groove and the venous sinus, is due to the motor-ganglia not being present to the same extent in all parts of the heart, and not to irritation of the inhibitory apparatus.

ACTION OF THE FASCIÆ OF THE THIGH ON THE CIRCULATION.—Braune (*Ber. der sächs. Gesell. d. Wiss.* 1870, p. 261, and *Centralblatt*, p. 399) finds that when the leg of a dead body is rotated outwards and moved backwards, the femoral vein becomes empty, and a negative pressure of ½ to 1 centimetre water is produced in it. On restoring the limb to its former position, or moving it forwards, the vein becomes quite full. Repetition of these movements, such as occurs to a certain degree in walking, sucks up the blood from the leg and presses it onwards to the body, the valves of the veins preventing it from flowing backwards.

ABSORPTION OF LYMPH BY TENDONS AND FASCIÆ.—In a research conducted under Ludwig's direction, Genersich (*Ludwig's Arbeiten*, 1870, p. 53) found that the lymphatics discovered by Ludwig and Schweigger-Seidel in fasciæ could be made to suck up a solution of alkanet in turpentine or ether. Thus a natural injection of them could be obtained. This was done by carefully freeing that side of an aponeurosis which was directed towards a muscle from connective tissue, stretching it tightly over a funnel, pouring upon it the alkanet solution, and then causing it to move up and down by sucking the air from the funnel. The lymphatics on the side next the muscle run in parallel lines, but on the side next the skin they form a net-work. They do not absorb granular fluids, while the centrum tendineum of the diaphragm does so readily. In order to discover what influence the contraction of muscles exerts on the sucking action of the aponeurosis, artificial circulation of blood was kept up in the hinder extremities of a dead dog which had been cut in two opposite the 7th dorsal vertebra, and the amount of lymph which issued from a cannula thoracic duct when the muscles were at rest, was compared with that which flowed when they were made to contract. The blood flowed into a cannula tied in the aorta, and out through one in the vena cava. At first, a slight pressure of blood was sufficient to keep up a brisk circulation, but after about two hours the flow became slow, and although it could be quickened again by raising the pressure, the acceleration was only temporary. This slowing of the circulation was due to contraction of the arteries. The contraction began in the arteries of the skin, and extended to those of the muscles. It was increased by the circulation of perfectly fresh blood, but was diminished, and the current quickened, by stopping the circulation altogether for a while. The acceleration, however, was merely temporary, and soon became slow again. Strong electric irritation of the arteries caused them to dilate. He does not know what the cause of the contraction is, but it is not due to rigor mortis, as the vessels dilated when it came on. The muscular contractility becomes much diminished when the circulation gets slow, but this diminution is partly independent of the slowing of the circulation. In its passage through the vessels the blood lost oxygen and became venous, the amount of albumen was much increased, and the sugar (substance reducing copper) which it contained was very much diminished. Other conditions being the same, the amount of lymph obtained when the muscles were caused to contract by electric irritation was much greater than when they were at rest, especially at the commencement of the experiment. This, however, is not so much due to the contraction of muscles pressing the lymph out of the lymphatics, as to the alternate tension and relaxation of the aponeuroses, since passive movements of the limbs produce a considerably greater flow of lymph than even the muscular contractions. When alkanet solution was injected between the aponeuroses and muscle it could be sucked up and flowed out at the thoracic duct of the limb by making passive movements, but if injected between the skin and the aponeurosis, none was absorbed. Although a large part of the lymph obtained is probably preformed, and merely sucked up from the tissues, yet a certain amount seems also to be formed during artificial circulation.

ABSORPTION WITHOUT CIRCULATION.—Goltz (*Pflüger's Archiv.* IV. p. 147) communicates a preliminary notice of certain experiments on the absorption, and conveyance through the system, of poisons after cessation of the circulation. His experiments consisted in injecting strychnia into frogs after tying the heart and vessels. These proved that even after complete cessation of the circulation the poison is carried to every part of the body, as shewn by the fact that it produces its local effects on the spinal end wherever injected, and likewise by the fact that other frogs fed with any portion of the poisoned frog exhibited symptoms of strychnia poisoning.

The author reserves for further experiments, and a future notice, his views regarding the forces concerned in the conveyance of the poison throughout the system.

VASO-MOTOR NERVES OF MUSCULAR ARTERIES.—Ludwig and Hafiz (*Ludwig's Arbeiten*, 1870, p. 93) continued the researches on the circulation of blood in muscles, which Sczelkow, A. Schmidt, Sadler and Genersich had already made under Ludwig's direction. Their experiments were chiefly performed on dogs and rabbits, and they recommend young animals for this purpose, as their vaso-motor system is more sensitive than that of old ones. In order to ascertain whether the vaso-motor nerves of the arteries which go to muscles agree in their properties with those of the vessels which supply the skin and viscera, all the vaso-motor nerves of the body were irritated at once, and the effect of this irritation on the arteries of the muscles compared with that on the vessels of the skin and viscera. The vaso-motor nerves were irritated by means of two electrodes inserted into the spinal cord, one opposite to the atlas, and a second at the under edge of the axis. The cord was previously divided between the occiput and atlas, and respiration kept up artificially. In order to eliminate the disturbing effect which the contraction of the muscles produced by irritation of the cord would have had on the circulation in them, the animals were generally poisoned by an amount of curare just sufficient to paralyze the motor nerves of muscles, but not enough to affect the vaso-motor system. The changes in the calibre of the arteries consequent on the irritation of vaso-motor nerves was noted in four ways. (1) By observing them with the naked eye or a lens. (2) By measuring the amount of blood which flowed out of the muscle when cut across, the larger arteries in it being ligatured previous to the measurement. (3) By the rapidity of the current as measured with the "strom-uhr."

(4) By the quickness with which the blood pressure fell when the heart was stopped by irritating the vagus.

The experiments made in these ways show (1) that when the cord is irritated tetanically the arteries of muscles contract, but to a much less extent than those of the skin and viscera, so that the diminution in their calibre is not apparent to the eye. The other arteries contract every time the cord is irritated, but those of the muscles do not. (2) The vaso-motor nerves of muscular arteries are easily exhausted, and when contraction does occur during irritation of the cord, it only lasts a short time, and relaxation occurs while the lumen of the dermal and visceral arteries is still continuing to diminish and the blood-pressure to rise. In consequence of this, the muscles bleed profusely when divided during irritation of the cord instead of scantily as they do when the blood-pressure is at its normal height. (3) During irritation of the cord the current in muscular arteries becomes more rapid, and if the heart be stopped the blood-pressure falls nearly as quickly as before, although the flow of blood through the dermal and visceral arteries is much diminished. (4) The coats of muscular arteries exhibit active contractions which are independent of the vaso-motor centre. They are distinguished from those produced by irritation of the cord by not extending over the whole length of the artery, but only affecting limited parts, so that the vessel sometimes looks like a string of beads. The periods at which they occur are quite independent of the irritation of the cord, and they persist during it notwithstanding the rise of pressure which then takes place. (5) The biceps femoris receives its motor nerves from the sacral plexus, but its vaso-motor nerves come from the lumbar plexus through the crural nerve, and accompany branches of the crural artery to the muscle. The moter and vaso-motor nerves can therefore be irritated separately. (6) In contradistinction to their nerves, the muscular fibres of the arterial coats of muscular arteries are very irritable, and to their properties the alterations in the circulation are in all probability chiefly due. They remain moderately contracted during the relaxation of the muscle provided that the muscular substance retains its normal composition. They contract strongly when exposed for a longer or shorter time to a high blood-pressure, probably from the extension they undergo acting as an irritant upon them. They dilate when the muscle contracts, or when it stops contracting, and also when the circulation in the muscle has been stopped for some time. In these cases alteration in the gases of the blood is not improbably the cause of the dilatation.

INHIBITION AND EXCITEMENT IN THE VASO-MOTOR CENTRES.—Cyon (*Bull. de l'Acad. imp. des Sciences de St. Petersbourg*, VII. Dec. 1870) considers that when a sensory nerve is irritated two kinds of reflex vaso-motor action are produced, one general and the other local. The general consists in contraction of all the vessels of the body, the local in dilatation of the vessels of the part supplied by the sensory nerve. From the former interfering slightly with the latter, a transient contraction precedes the permanent local dilatation of the vessels. When the animal is narcotized, or the cerebral hemispheres removed, irritation of a sensory nerve produces dilatation instead of contraction of all the vessels in the body, and the local dilatation then occurs immediately, instead of being preceded by contraction. When the whole cerebrum is extirpated, and only the cerebellum and medulla remain, irritation of sensory nerves produces no reflex action whatever on the vessels. He thinks that every irritation of a sensory nerve when conveyed directly to the vaso-motor centre has an inhibitory action on it and produces reflex paralysis of the vessels, but when conveyed first to the brain, and thence to the vaso-motor centre, it has an exciting action, and produces increased contraction of the vessels. It is always conducted directly to the vaso-motor centre of the part which it supplies, and thus invariably produces local vaso-motor paralysis.

POSITION OF THE VASO-MOTOR CENTRE.—Ludwig and Owsjannikow (*Ber. der sächs. Gesell. der Wiss.* 1871, p. 135, and *Centralblatt*, p. 483) find that the vaso-motor centre lies in the medulla oblongata from 1 millimetre under the corpora quadrigemina to 4—5 millimetres above the calamus scriptorius, and to one side of the middle line. They determined this by cutting holes with a trephine through the skull of curarized rabbits or cats, on each side of the middle line, and then dividing the brain substance from the middle line outwards by means of small knives. Sections through the corpora quadrigemina produced a transient rise of blood-pressure: between the corpora quadrigemina and medulla oblongata a slighter rise. The rise was often accompanied by peculiar oscillations. Sections in the medulla oblongata produced a fall in the blood-pressure. The lower the section, the greater was the fall. The upper boundary of the district in which a section caused sinking was 1 millimetre below the corpora quadrigemina, the lower border 4—5 millimetres above the calamus scriptorius. A section made at the upper boundary had no effect on the action of the depressor, or on the rise of pressure after irritation of a sensory nerve; a section between the upper and lower boundary diminished these actions, and one at the lower boundary completely destroyed them. The vaso-motor centre, therefore, lies in this district, and to one side of the middle line, as sections made in the middle line had no effect. The cerebellum has no connection with the blood-pressure. Sections above the medulla, or irritation of the sciatic nerve, always quickened the heart. Chloral produces a great sinking of the blood-pressure. Large doses of it destroy the power of sensory irritations to raise the blood-pressure, but small ones do not. The temperature falls after its administration independently of the blood-pressure.

INFLUENCE OF THE NERVOUS SYSTEM ON THE CIRCULATION AND TEMPERATURE.—Riegel (*Pflüger's Arch.* IV. 350—428) contributes the results of numerous experiments made by himself in reference to this subject, and combines with them a long critique of the numerous researches which have been made of late years in the same direction. He corroborates the occurrence of rhythmical contractions in the vessels as described by Schiff in the ear of the rabbit, Wharton Jones in the veins of the bat's wing, Saviotti in the web of the frog, and describes them also in the mesentery of the frog and in the arteria saphena of the rabbit, where they are to be seen with great distinctness. (The occurrence of these rhythmical movements in the vessels of the rabbit generally had, however, been previously observed by Ludwig and Brunton. See Ludwig's *Arbeiten*, 1869.) These movements are under the influence of the vaso-motor centre. Irritation of the vaso-motor centre causes contraction, especially of those vessels which most distinctly manifest rhythmical contractions. The general effect of such irritation, if it only affected limited vascular provinces, would be to aid the propulsion of the blood onwards into other regions, even though the circulation as a whole would be retarded.

Riegel does not observe an invariable fall of temperature on irritation of sensory nerves, and does not regard Heidenhain's explanation (see this *Journal*, May, 1871) as satisfactory.

RAPIDITY OF CIRCULATION IN THE VEINS.—Cyon and Steinmann (*Bull. de l'Acad. des Sciences de St Petersbourg*, XVI. 266) found that the amount of blood which flowed in a given time through the jugular or crural veins of dogs narcotized with opium or chloral was nearly the same as that which flowed through the corresponding arteries. The velocity of the current in veins is therefore much greater than that calculated by Volkmann. The rapidity of the current in the veins undergoes variations similar to that in the arteries, so that it is much diminished in the jugular when the carotid of the same side is compressed, but is increased by compression of the carotid on the opposite side. Division of the spinal cord lowers the blood-pressure, and thus lessens the rapidity of the current. Irritation of the cord generally raises the blood-pressure in dogs only to a slight extent, and as it causes contraction of the arterioles, it generally lessens the rapidity of the current. Sometimes division of the cord is followed by a slightly increased rapidity of the current. Irritation of a sensory nerve produces general contraction of the arterioles, and temporary contraction succeeded by dilatation in the part supplied by the nerve. When the tibial nerve was irritated the rapidity of the current in the crural vein was increased on one occasion so much that Cyon thought it due to local dilatation of the arteries occurring at the same time as a general increase of blood-pressure. At other times the rapidity became greater as the blood-pressure sank, apparently from the contraction of the arterioles, which had slowed the current in spite of the increased blood-pressure having given way to dilatation. If no rise of blood-pressure occurred, the stream in the veins was slowed by the contraction of the arterioles. Stoppage of artificial respiration in curarized dogs increased the rapidity of the current, and it only began to diminish when they were becoming asphyxiated. If the trachea of dogs which were not narcotized was closed when their lungs were distended with air, the rapidity of the current in the veins became rapidly diminished in consequence of venous congestion.

CAUSE OF VASCULAR MURMURS.—Nolet (Heynsius's *Onderzoekingen*, II. p. 135, and *Henle* and *Meissner's Jahresbericht*, 277) finds that a murmur can occur in a tube of equal diameter throughout, if the stream passing through it has a sufficient velocity. The velocity necessary is greater than that found by Weber and Thamm. The narrower the tube, and the smoother the walls, the greater is the velocity necessary. The intensity of the murmur was equally great over the whole of a tube 18 inches long or more. A constriction in the tube causes a murmur both behind and in front of it, and the narrower the constriction, the less is the velocity of stream required. The murmur in front is weaker than the one behind, and a greater velocity is required to produce it. If the constriction was long enough, and of proper character, no murmur could be heard in its middle. A dilatation of the tube produced a murmur at the point where it began, and where it ended. A greater rapidity was necessary to produce a murmur at its end than at its beginning. The wider the dilatation the greater the rapidity required, and if it be very wide the velocity must be greater than that which is necessary in a tube of equal diameter throughout. Where an aneurism is very wide no murmur may be produced. The murmurs are due to vibrations in the fluid produced by vortices and strengthened by the walls of the tube acting as resonators. These vortices he rendered visible by means of powdered amber, and they corresponded in size to the intensity of the murmurs. As the rapidity of the circulation in arteries at a distance from the heart is less than in those near it, roughness of the walls does not so easily cause a murmur in them.

COAGULATION OF FŒTAL BLOOD.—Boll (*Du Bois' and Reichert's Arch.* 1870, p. 718) finds that the blood in the fœtal chick before the 12th or 14th day does not coagulate, but merely deposits a sediment of blood-corpuscles. At the 13th or 14th day it forms small and scanty coagula which are red from enclosed corpuscles. On the 16th or 17th day it begins to coagulate completely, but not so firmly as that of a developed bird. The non-coagulation in the first stage is due to want of fibrinogen. Fibrinoplastic substance is present, and when a few drops of blood from a chick about the 8th day are added to pericardial fluid, a jelly-like coagulum is at once formed. Hæmoglobin can be distinguished by the spectroscope in the blood on the 3rd day of incubation.

Respiration.

INFLUENCE OF THE MEDULLA ON RESPIRATION.—Schiff (*Pflüger's Archiv.* 225—34) by further experiments confirms his statements which had been questioned by Brown-Sequard, that, at the level of the first cervical nerve the lateral columns of the medulla regulate the respiratory movements of the corresponding side. Section of the columns at this level causes entire cessation of the respiratory movements on the same side, except in so far as that passive movements may still be observed, due to the active movements of the other side or abdomen. In a rabbit in which the lateral column on one side was divided the volume of air respired was reduced one third of the normal.

INFLUENCE OF THE VAGUS ON THE AIR-CELLS OF THE LUNG.—Schiff (*Pflüger's Archiv.* IV.) shows that the expulsion of air from the lungs which results from stimulation of the vagi immediately after death is partly due to contraction of the air-cells themselves. It is therefore probable that the vesicular emphysema observed in various parts of the lungs after section of the vagi in dogs and other animals is due to some extent to the paralysis of the air-cells which ensues.

POST-MORTEM APPEARANCES ON BRAIN LESIONS.—Fleischmann (*Jahr. für Kinderheilk.* IV.) confirms the facts observed by Brown-Sequard on lesions of various parts of the brain (see *Journal of Anat. and Phys.*, May, 1871). He found in cases of tubercle of the hemispheres, corpora quadrigemina, optic thalami and pons, apoplectic extravasations on the pleuræ, pericardium and surface of the kidneys, and in one case patches of emphysema in both lungs.

EXTRAVASATION IN THE LUNGS AFTER DIVISION OF THE VAGUS.—Valentin (*Zeitschrift f. Biologie,* VII., p. 160, note) thinks the scattered extravasations which appear in the lungs after division of the vagi are due to mechanical efforts, especially to the laboured respiration. In one case he found them in a quarter of an hour after the vagi had been cut.

INFLUENCE OF CHANGE OF ATMOSPHERIC PRESSURE ON THE BODY.—G. v. Liebig (*Archiv. f. Klin. Med.* VIII. 445—60) seeks to determine, with a view to the therapeutics of chronic lung diseases, what influence is exerted on the respiration by increased or diminished atmospheric pressure. As is well known, respiration at high altitudes with low barometric pressure is exceedingly difficult. This is due to the greater elastic recoil of the lung tissue from diminished atmospheric counterpressure. Hence the difficulty of inspiration and the disturbance of circulation. Under increased barometric pressure the phenomena are quite the reverse. The respiration is unusually easy and deep. The pulse also becomes slower. The influence of increased or diminished pressure is not of momentary duration, but persists for some time. Residence at high altitudes has therefore a tendency to develope the respiratory power and the strength generally. From the influence of diminished atmospheric pressure on the lungs the advantages of residence at high altitudes in cases of emphysema will be apparent. Emphysematous lungs having lost their elasticity and offering resistance to the pulmonary circulation may regain their tone and respiration become easier. In all cases of diminished elasticity of tissue from any cause residence at high altitudes under low barometric pressure is advisable.

EFFECT OF ALTERATIONS IN ATMOSPHERIC PRESSURE.—Bert (*Compt. Rend.* LXXIII. p. 213) finds that warm-blooded animals become convulsed and die rapidly if the atmospheric pressure be quickly reduced to 15 or 18 cm. of mercury. After death the bronchi are found filled with bloody foam, and the blood is dark on both sides of the heart. Death takes place equally quickly whether the bell-jar under which the animal is placed be closed completely or be traversed by a stream of air. If the pressure be diminished gradually, and a current of air be kept up, the animal will live for a considerable time under a very low pressure, but if the current be stopped they die of asphyxia. The composition of the air in which the animal dies varies with the pressure. Birds die at a pressure of 18 cm. of mercury, mammals at 12 centimetres.

ALTERATIONS IN THE AMOUNT OF AIR IN THE LUNGS DURING THE MOVEMENTS OF THE HEART.—Landois (*Berlin. Klin. Wochensch.* 1870, p. 9) connected a manometer with the trachea and found that air was not drawn in but driven out of the lungs during the systole of the heart.

Ceradini (*La meccanica del Cruore osmodei annali universali di medicina*, see IV. Vol. 75, p. 587, and *Henle's Jahresbericht*, 1870, p. 270) connected a manometer with the trachea, and saw that air was drawn into the lungs synchronously with the radial pulse. By using a sensitive registering instrument which he calls Hæmothorakograph, he found that during a small fraction of the duration of the systole, just at its beginning, the amount of arterial blood in the thorax remains unaltered, while venous blood still comes in, and therefore there is a slight expiration of air. Then arterial blood leaves the thorax more quickly than venous blood enters, causing a slight inspiration. As the systole ends there is a reflux of arterial blood towards the heart, and at the same time venous blood streams into the thorax. This causes a slight expiratory movement, which, however, does not quite counterbalance the previous inspiration, and lastly, the air in the lungs returns with slight oscillations to its former volume.

INFLUENCE OF THE LACHRYMAL GLAND ON RESPIRATION.—Bergeon (*Comptes Rendus*, 1870, I., p. 88. Henle's *Jahresber.* 1870, p. 162) thinks that one of the chief functions of the lachrymal gland is to keep the nasal mucous membrane and the inspired air moist, and thus preserve the mucous membrane of the respiratory passages from getting too dry.

Temperature.

COOLING OF WARM-BLOODED ANIMALS.—Horvarth (*Centralblatt für Med. Wiss.* p. 531) has succeeded in cooling young dogs till the temperature in the rectum fell to 6·6° C. or even to 4·8° C., and again restoring them to their normal condition by means of warmth. On cooling rabbits to 7° C. and a cat to 9·5° C. no respiratory movements or cardiac pulsations could be observed, and the strongest electric currents applied to muscles or nerves had no effect. After they had been in this condition for an hour he poured warm water on them. The heart then began to pulsate and continued to do so for an hour, and electric currents applied *directly* to the muscles produced vigorous contractions, but the strongest currents applied to the nerves had no effect. This affords an additional proof of the contractility of muscles independently of nerves.

INFLUENCE OF HEAT ON ANIMALS.—Bernard (*Revue Scientifique*, 1871—72, pp. 133 and 182) investigates the action of temperature, by placing birds and rabbits in cages heated by a lamp or surrounded by a double metallic case containing a hot solution of sulphate of soda. When the animals are thus exposed to a dry heat of 150° F., the respirations become quick and tumultuous, the temperature of the body rises, the heart beats quickly, and after a little stops suddenly if the temperature be high enough. The necessary temperature is sooner reached in birds than rabbits. It rose in birds to 122°, in rabbits to 115° F. Rigor mortis came quickly on, and both arteries and veins contained black blood. The blood from the vena cava contained 37·2 per cent. carbonic acid, 3·4 nitrogen, and only 1 per cent. oxygen. The dark colour is due to rapid and extreme deoxygenation after death, as arterial blood collected immediately after death is of a scarlet colour. The rapid deoxygenation is due to the high temperature, exactly the opposite condition being found in animals exposed to cold, the blood being then scarlet both in the arteries and veins. Blood drawn directly from an artery into a closed glass tube and gradually warmed suddenly becomes dark, and between 140° and 158° F. it coagulates, and does not recover its bright colour when exposed to air. Involuntary muscles are very sensitive to temperature and variations, and produce contractions in them, but voluntary muscles are not. When animals are killed by warmth the irritability of the heart is entirely lost immediately after death. The stoppage of the heart by heat is, he thinks, due to coagulation of its myosin. From experiments on curarized frogs he finds that a temperature which destroys the irritability of muscles does not destroy that of motor nerves; but sensory nerves, on the other hand, lose theirs at a lower temperature than muscle.

Lauder Brunton (*St Bartholomew's Hosp. Reports*, p. 216) tested the action of temperature on the action of the vagus, and on the rate of cardiac pulsations, by wrapping rabbits narcotized with opium or chloral in cotton wool and laying them in a double case filled with hot water. The pulsations of the heart were registered on a revolving cylinder by one of Marey's levers, which was attached by a thread to a needle fixed in the ventricle, and the temperature taken by a thermometer kept constantly in the rectum. As the temperature of the animal rose the pulsations of the heart became more and more rapid till they reached a maximum, their number then quickly diminished, they became irregular, and soon stopped completely. The pulsations did not increase at the same rate throughout as the temperature rose, and the number of beats at any given temperature, as well as the amount of quickening for each degree of rise, vary in different animals. The temperature at which the heart stopped was between 113° F. and 114° F. or even more, but it varied in different animals, and seemed to be much lower when a large dose of chloral had been given.

Division of the vagi before warming the animal appeared to have little or no effect on the quickening of the pulse by heat. In one case when they were not cut there were two maxima in the pulse-rate, one at 105° F. and the other at 113°. As the temperature rose and the pulse became quicker the power of the vagus was diminished, so that the same irritation which at first had produced still-stand, only caused slowing. When the same irritation was applied after the maximum was past and the heart had again become slow, just before death, still-stand was again produced. Irritation of the vagus immediately after death was followed by an undulating movement in the heart.

REGULATION OF TEMPERATURE.—Röhrig and Zuntz (*Pflüger's Arch.* IV. p. 57—90) uphold the doctrine of Liebermeister, that the production of heat in the body is dependent on the temperature of the surrounding medium. Cold within certain limits increases the tissue-change, and with it the production of heat. Heat has an opposite effect. They explain this in the following manner. That by the cooling of the skin the cutaneous nerves are stimulated, and through them a reflex increase of the tissue metamorphosis is produced. From this it would appear probable that other stimulants of the skin might have a similar effect, and such in reality seems to be the effect of sea- and mineral-baths as distinct from fresh-water baths of the same temperature.

The muscles are the chief seat of the heat-production, and this stands under a constant influence of the nervous system even without apparent muscular contraction. The reflex heat production by irritation of the cutaneous nerves is reduced to a minimum in animals paralysed by curara.

The increase of temperature in the axilla which Liebermeister took for a proof of increased heat-production when the skin was cooled, they refer to the influence of the axillary vein on the thermometer. They found that movement of the arm without altering the position of the thermometer caused a rise in temperature in the axilla of from one-fifth to two-fifths of a degree.

ACTION OF CURARE ON TEMPERATURE.—Riegel (*Centralblatt für Med. Wiss.* 401) confirms the opinion of Röhrig and Zuntz, that the warmth of the body is chiefly produced in the muscles. He finds that when these are prevented from acting by poisoning with curare the temperature of the animal goes on constantly falling, although artificial respiration be carefully kept up, and the action of the heart and the functions of sensory and vaso-motor nerves remain unaffected by the poison. When the animal was previously rendered feverish by the injection of pus into its veins the temperature was not only reduced to the normal, but even below it.

MEANS OF LOWERING THE TEMPERATURE.—Manasseïn (*Pflüger's Archiv.* IV. 283—301) writes on the influence which "rocking" exerts on the temperature of animals. He finds that by this means the temperature is lowered from 0·66 – 1·2° C. It seems to be a physiological effect brought about by the agency of the nervous system.

INFLUENCE OF COOLING ON THE PRODUCTION OF HEAT.—Winternitz (*Wien. Med. Jahrb.* N.F., 1871, II. p. 18) denies the trustworthiness of Liebermeister's method of measuring the amount of heat given off from a body by the rise of temperature in the water of a bath in which the body is placed, and shows that even after the water has been carefully stirred its different layers present considerable differences in temperature. He does not attribute the rise of temperature which occurs in the axilla when the surface of the body is cooled to increased production of heat but to congestion in the periphery, as it can be produced by a tourniquet on the arm. No conclusion can be drawn from the temperature in one part of the body regarding that in another, as when cold was applied to the back in one case, the temperature rose in the axilla but fell in the rectum. The differences in temperature of different parts are due, he thinks, to reflex changes in the vaso-motor nerves.

ON REGULATION OF TEMPERATURE.—Senator, *Virch. Arch.* LIII. p. 111.

Liebermeister, *Virch. Arch.* LIII. p. 434, replies to the criticisms of Winternitz and Senator.

Gildemeister (*Diss. Basel*, 1870, *Henle and Meissner's Jahresber.* 1879, p. 208) finds that cooling the body causes increased production of Co_2 both in health and in fever. In fever, however, although the cold bath increases the combustion and production of heat in the body it withdraws more heat than is produced, and therefore cools the body and does good.

Wertheim (*Wien. Med. Wochensch.* 1870, pp. 297, 325, 353, 389, 421) found that when the temperature of a dog was lowered by the application of ice the depth of respiration and amount of CO_2 expired was much increased. The CO_2 was increased both absolutely and also relatively to the amount of air respired.

INFLUENCE OF WARM SULPHUR BATHS ON TEMPERATURE.—Boettcher (*Dorpat. Med. Zeitsch.* 1870 I., 21, and *Centralblatt*, 1871, p. 623) found that in sulphur baths from 34 to 35° C. the temperature and axilla rose on an average 0·1° C.; in the baths at 35° to 36° C. it rose 0·25° C., in those at 35 to 36·4° C. it rose 0·34° C. As Kerner had found that in baths of ordinary water at 34° the temperature fell 0·36° C., and in those about 36° C. it rose only 0·121° C., it seems that the temperature in the axilla rises higher in sulphur-baths than in ordinary water.

PERSPIRATION IN FEVER.—Pudzinowitsch (*Centralblatt*, p. 211) draws the following conclusions from experiments made with Weyrich's apparatus. The transpiration from the skin has no relation to the temperature. It may be diminished when the temperature is higher and increased when it is lower, as was seen in two cases of acute rheumatism, and one of pleuropneumonia. At a high temperature (39° – 41° C.) it was diminished in two cases of remittent fever, and increased in two of typhus. In two cases of typhoid complicated with ague it increased or diminished in proportion as the temperature rose or fell.

Muscle.

THEORY OF MUSCULAR POWER.—Luchsinger (*Pflüger's Archiv.* IV. 201—205) does not confirm Volckmann's theory, that the extension of an active muscle by means of a weight which equals the absolute power of the muscle, always stands in a constant relation to the lifting-height of the unweighted muscle. He shews that this theory, if correct, would not harmonize with the commonly accepted Weber's theory of muscular activity, and that a muscle should be equally distensible by all degrees of stimulation, whereas it is known that the extensibility of a muscle is in proportion to the degree of stimulation.

ELASTICITY OF MUSCLE.—Fick (*Pflüger's Arch.* IV. 301—315) describes a form of myograph, in which the tension of the muscle is kept constant, and therefore adapted for determining how, during the state of activity, the length of the muscle varies, the tension remaining the same. Neither Helmholtz's nor Marey's myograph fulfils these conditions. The instrument in principle is a modification of Marey's, in which, however, the resistance to the muscle is not the elasticity of a spring whose tension varies during the movement of the lever, but a constant weight suspended on the lever. By a slight modification the instrument can be made to determine how, during the course of contraction, the tension of the muscle varies while the length remains the same. From a comparison of pendulum tracings it is found, that when the irritation of a single momentary stimulus is allowed to proceed in the first instance, so that the muscle can contract while the tension remains constant, and next, so that with its length remaining the same the tension varies, the muscle in the latter case sooner attains its maximum of tension, than in the former case, its maximum contraction, i. e. its minimum length. Also, it appears that after momentary irritation the tense muscle becomes flaccid much sooner than the contracted muscle again returns to its former length. The specific elasticity of the muscle diminishes in the course of contraction, at first quickly, and then more slowly. The elasticity of the muscle is, therefore, in no respect a simple function of its natural length, but has different values for each degree of contraction.

DIMINUTION OF MUSCULAR POWER DURING CONTRACTION.—Hermann (*Pflüger's Archiv.* IV. 195—201) confirms Schwann's statement, that there is a diminution of muscular power during contraction. By graphic representation it is shewn that the curve of extension (Dehnung's curve) of the active muscle has the form of a hyperbola, similar to that of the inactive muscle. This is a new confirmation of Weber's theory of muscle.

MUSCULAR TONE.—Sustschinsky (*Centralblatt*, No. 34, 1871) investigates the conditions of muscular tone in the hinder extremities of the frog and the influence of some poisons on the same.

MUSCULAR RIGIDITY.—Hermann and Walker (*Pflüger's Archiv.* IV. 182—195) investigate the phenomena of muscular rigidity. As to the time of shortening by spontaneous rigidity, it was found that it does not proceed gradually after the separation of the muscle from the body, but begins after a few hours, and advances at first with considerable rapidity, and afterwards more slowly. They confirm the observation of Schmulewitsch, that in muscular rigidity induced by heat a distinct diminution of the volume of the muscle occurs. As to the absolute force of rigidity, they found that, as a rule, it is less than the power exerted by muscle on strong electrical stimulation, though sometimes fully equal or even greater. On a comparison of the amount of shortening of active and rigid muscles, it was found that light weights are raised higher by the rigid muscle, while heavy weights are raised higher by the living active muscle; which proves that the "natural form" of the rigid muscle is shorter and more extensible than the contracted living muscle. In regard to rigidity produced by a strong degree of cold, Hermann finds it depends on the rapidity of the freezing, whether a muscle will remain excitable after it is thawed or not. Contractions are caused by very rapid freezing, not if the freezing has been gradual. Neither the temperature to which the muscles are exposed after freezing, nor the duration of the frozen condition, nor the rapidity of thawing, have any influence on the rigidity. Muscles become rigid and acid even at such a low temperature as 0°; and this is the case even with muscles which have previously been frozen and then exposed to this temperature.

ELECTRO-MOTOR PROPERTIES OF MUSCLES AND NERVES.—Hermann (*Pflüger's Archiv.* IV. 149—182) adds some new observations to his already published views regarding the nature of the electro-motive currents observed in muscles and nerves. He finds that in plants, as already stated by Buff, the transverse section is always negative to the longitudinal, and that artificial longitudinal sections are negative to the uninjured surface. Experiments with heat and substances destructive to the tissue, shew that the currents stand in close relation to the vital phenomena of the plant, and that their chief conditions are the presence of an injury to the yet living plant, just as in muscle, the currents being generated by the dissimilarity between living and dying protoplasm. Hermann has also made numerous observations as to the influence of temperature on the electro-motor properties of muscle. He had hoped by experiments on this point to bring to a crucial test his own theory, and the molecular hypothesis of Dubois Reymond. Curiously enough, however, the results obtained are explicable on either hypothesis. He found (1) between 0° and 30° the electro-motor power is greater at higher than at lower temperatures. Freezing and coagulation by heat destroy the properties utterly. (2) Cooled portions of muscle are negative, while warmed portions are positive to the other parts of the muscle. Freezing and heat-rigidity make the parts affected negative to the others. (3) Cooling or warming the transverse section has no appreciable influence on the electro-motor relation between this part and others. Freezing or heat-rigidity, however, increases its negativity, just like "freshening" the section. These latter facts militate against Hermann's previously expressed view, that the negativity proceeds *pari passu* with the degree of molecular disturbance (Spaltungsverschiedenheit), for then it should be expected that the colder muscular substance would be less negative, whereas exactly the opposite is the case. Hermann, however, still denies the pre-existence of the muscular current.

LAWS OF MUSCULAR EXHAUSTION.—From the experiments which Kronecker (*Monatsber. der Akad. zu Berlin,* 1870, p. 629) has performed with a highly complicated and most ingenious apparatus he deduces the following laws of muscular exhaustion. (1) If a muscle overloaded with a definite weight is irritated at equal intervals by equal (maximum) opening and closing induction shocks, the height of the contractions form an arithmetical series, in which the constant difference depends only on the interval of time. If the muscle is loaded, instead of overloaded, the law only holds good for that height of contraction which is equal to the stretching caused by the weight. (2) When the intervals of time and the overload vary, the law is more general. The height of any contraction with an overload p, and an irritation which follows the previous one after an interval of time θ, is the same as if all the previous irritations had followed each other at an equal interval of time θ, and all the contractions had been made under the same weight. (3) Therefore the diminution in the height of contractions is independent of the weight, and only depends on the interval between two contractions. (4) The changes of irritability disturb to a certain degree the expression of the previous laws. (5) Exhaustion can be partly removed by the injection of blood serum, dilute salt solution, to which a little permanganate of potash has been added, or even by pure salt solution.

HÆMOGLOBIN IN MUSCLE.—Ray Lankester (*Pflüger's Archiv.* 315—20) shews that hæmoglobin occurs in the pharyngeal muscles of gasteropodous molluscs, such as Limnæus and Paludina, while no hæmoglobin exists in the blood. From its occurrence here, and from the fact that it is found universally in the strongest and most active muscles (heart) of all vertebrates, and also in the muscles of the rectum and not in the rest of the alimentary canal, the author thinks there is some definite relation between hæmoglobin and muscular activity.

CHEST AND FALSETTO NOTES.—Mandl. (*Wien. Acad. Sitzber.* 2 Abth. LXII. 264—70) describes the condition of the larynx in chest and falsetto notes. In chest notes the rima glottidis is open to its whole extent, and the vocal cords vibrate throughout their whole length. In the deepest notes the rima glottidis is elliptic, the widest part being about the middle of the ligamentous structures. The higher the notes, the nearer the processes vocales of the arytenoid cartilages approach each other, but the glottis respiratoria always remains open, and the vocal cords vibrate in their whole length and breadth. In falsetto notes, on the other hand, the glottis respiratoria is shut, and only the pars vocalis of the vocal cords vibrates. In the deepest notes of this register the whole pars vocalis vibrates; in the higher, however, the false vocal cords apply themselves to the true vocal cords in front, behind, and at the sides, so that only the middle parts of the latter vibrate, and then only with their edges. The closure of the glottis respiratoria, which is necessary to falsetto, is brought about by the action of the arytenoid muscle, which moves the arytenoid cartilages on the facets of the cricoid from the under and anterior part to the upper and posterior. The crico-arytenoidei laterales alone can narrow the rima glottidis by swinging the arytenoid cartilages on their vertical axis, but cannot cause complete closure.

Digestion.

PHYSIOLOGY OF VOMITING.—Grimm (*Pflüger's Archiv.* IV. 205—209), considering the movements concerned in the act of vomiting to be merely abnormal respiratory movements, regulated, as Gianuzzi has supposed, by some centre in the medulla oblongata, has turned his attention to the respiratory centre itself and experimented in how far the condition of apnœa might influence the act of vomiting. He found that when artificial respiration was vigorously maintained, the act of vomiting was very rudimentary and insufficient to empty the stomach, and also that on exhibition of tartar emetic artificial respiration is never able to cause entire cessation of the natural respiratory movements. These facts confirm the idea that the acts of respiration and vomiting are innervated by the same centre and that the emetic causes a peculiar irritation of the respiratory centre. The exact nature of this irritation is a subject for further investigation.

MOVEMENTS OF INTESTINE.—Sanders Ezn (*Maandblad van de Genootschap ter bevordering van Natuur Genees en-Heelkunde te Amsterdam*, 1870-71, No. 6, and 8, and *Centralblatt*, p. 479) ties the œsophagus and rectum, and opens the abdominal cavity of animals while they are immersed in a 0·6 per cent. solution of Na. Cl and thus avoids the irritation of the intestines, which would be caused by their exposure to air. In doing this the intestines are found to be at first perfectly motionless. Sometimes contractions of their longitudinal or circular fibres occur. The former are generally local, but their extent alternately increases and diminishes, and thus causes an undulating movement in the intestines. The latter often extend downwards along the intestines. Mechanical irritation of the intestines has little effect in producing movement. The amount of blood in the vessels changes without any apparent cause, but often remains constant for a long time. Dyspnœa causes the vessels to contract, but they again relax when the breathing becomes normal. The amount of blood in the vessels has no influence on the movements of the intestine. Compression of the aorta produces no movements in the intestine when at rest, and may even diminish movements when they are present. The uterus behaves in a similar way to the intestine. The violent movements of the intestines, which generally occur during suffocation, do not take place if the vagi are previously divided in the neck. Irritation of their peripheral ends produces the movements. These occur chiefly in two places, the under end of the duodenum and the upper end of the ileum. Irritation of the right vagus chiefly causes movement in the duodenum, and irritation of the left movement in the ileum. The stomach sometimes remains quiet, but generally it expels part of its contents from time to time into the duodenum. In one case of diarrhœa he saw antiperistaltic movements in the colon, in all other parts the movements were peristaltic. The urinary bladder sometimes presented movements even when empty. These are always peristaltic. The horns of the uterus present peristaltic and antiperistaltic movements.

ABSORPTION OF FAT.—S. V. Basch (*Wien. Acad. Sitzber.* LXII. 2 Abth. 1870, 617—634) holds that the central lacteal of the villus stands in open communication with the lacteal passages which permeate the villus, and is devoid of epithelium. The particles of fat permeate the base of the epithelium of the villi. There is, however, no direct communication between the epithelium and the lacteals, there being only a close contiguity between the margin of the villus and the epithelial cells. The appearance of fat particles between the epithelial cells often observed after death is due to a sort of extravasation or regurgitation from the lacteals.

FUNCTION OF THE SPLEEN.—Mosler (*Centralblatt*, No. 19, 1871), in a preliminary notice, gives the results of 30 cases of extirpation of the spleen, and draws the following conclusions: (1) The spleen is not necessary to the life of the animal. (2) After extirpation as well as after artificially caused atrophy of the spleen, its function is undertaken by other lymphatic organs, especially by the medulla of bones. Marked changes are seen in this after extirpation of the spleen. Hyperplasia of the lymphatic glands is not a constant phenomenon. (3) The vicarious action of the lymphatic glands is not complete at first, as the blood is altered in character for the first few months after extirpation. The spleen has a direct influence on sanguinification, and is apparently concerned in the formation both of white and red corpuscles. (4) The spleen has no influence on the gastric or pancreatic digestion. The great appetite which is said to follow extirpation of the spleen is not a constant occurrence.

SECRETION OF URINE.—A paper by C. Ustimovitsch (in *Ludwig's Arbeiten*, 1870, p. 198) contains much interesting information on this subject. He shows that the secretion of urine is the product of two factors, one of which is the difference of pressure between the circulating blood and the excreted urine, and the other the amount of urinary material which the blood contains. Max Hermann had found that the secretion of urine depends on the difference of pressure between the blood in the renal arteries and the urine in the ureter, and that secretion might be arrested either by lessening the pressure of the blood or increasing that of the urine. Ustimovitsch shows that when the amount of urinary material in the blood is about the same, the secretion of urine goes on in proportion to the difference between the pressure in the blood-vessels and that in the ureters. No secretion takes place when the blood-pressure sinks below 40 mm. of mercury. He points out that the pressure of blood in the renal arteries is quite a different thing from that in the systemic arteries generally. It must sink along with the pressure in the aorta, but the muscular coats of the renal arteries may contract and cause it to fall though the general tension in the aorta remains high. This contraction may be due either to the vaso-motor centre or to causes in the kidney itself. Section of the renal nerves separates the arteries from the vaso-motor centre, and therefore generally causes the contraction to relax and increases the amount of urine. Sometimes, however, local causes prevent the contraction from relaxing, even when the nerves are cut, and in those cases section of the nerves does not increase the secretion. Section of the splanchnic has the same action as division of the renal nerves, but it also produces diminution of the blood-pressure, and therefore does not increase the secretion so much. Section of the cord at the lower part of the neck stops the secretion of urine. If Na. Cl or urea be then injected into the veins, secretion begins again notwithstanding the great diminution in blood-pressure which follows section of the cord. For a criticism of Eckhard's theory of secretory and inhibitory nerves, we must refer to the original. As regards the proportion of of water, urea and chlorine secreted in a given time, Ustimovitsch finds that when the blood-pressure sinks, all three are more scantily secreted. When the urine first secreted is rich in urea, its amount becomes diminished more quickly than that of the water, but if it is poor the water diminishes before the urea. Section of the renal nerves generally increases the urine, and in these cases the water increases much more quickly than the urea. When the resistance in the ureter is raised so that secretion becomes scanty, the urea diminishes much more quickly than the water. The same is the case when the urine which flows out without any resistance contains 3 per cent. of urea. When the amount of Na. Cl in the blood is augmented, the secretion of urine becomes increased; the Na. Cl rises quicker than the water, and with every additional gramme of Na. Cl excreted a very constant weight of water (14—16 grm.) passes out. Increase of the amount of urea in the blood has an inconstant effect. Curare poisoning stops, or greatly lessens, the secretion of urine, and the chlorine and urea are more diminished than the water. When the renal nerves are cut, secretion again commences, but the urine remains watery and very poor in urea and Na. Cl even though these be injected into the blood. This he ascribes to a specific action of curare on the urinary secretion. When artificial respiration was stopped, and the curarized animal became asphyxiated, the urine began to flow more rapidly.

PARTICIPATION OF THE KIDNEYS IN THE FORMATION OF UREA.—Rosenstein (*Centralblatt*, No. 23, 1871, p. 353) investigates what part, if any, the kidneys play in the formation of urea. He considers all previous methods faulty which consist merely in analysis of the blood going to, and the blood returning from, the kidneys. His method was to compare the amount of urea in the urine of a dog retaining both kidneys with the amount after extirpation of one of them. The result was, that as much, if not more, urea was excreted when only one kidney was present as when both existed. This might be attributed to complementary hypertrophy, but the results were observed long before any hypertrophy could have taken place. The conclusion is, that the kidneys have nothing to do with the formation of urea.

Miscellaneous.

ABSORPTION OF INSOLUBLE SUBSTANCES.—Auspitz (*Wien. Med. Jahrb.* N. F. 1871, III.) gives the results of experiments on rabbits with regard to the absorption of starch suspended in water or oil. Starch injected into the veins reaches the lungs, where the greater part is retained, without producing serious inconvenience or inflammation. A small portion of the granules reach the liver, spleen, and the vessels generally. Injected into the abdomen, or subcutaneous cellular tissue, starch suspended in water, but particularly if suspended in oil, reaches the circulation and the viscera. Oil injected subcutaneously diffuses itself in the meshes of the subcutaneous and muscular connective tissue, and reaches as far as the serous linings of the hollow cavities. Inflammatory symptoms were not observed in the organs, but often hæmorrhagic extravasations. Wherever injected, starch was found in the thoracic duct. After infriction of starch and oil into the skin of rabbits, immediately before or after its separation from the body, these substances were found in the corium, the subcutaneous cellular tissue and the attached muscles, but not in the sebaceous or hair-follicles. The process of friction was carried on for a quarter of an hour. Fats greatly favour absorption of substances.

ELECTRO-MOTOR PHENOMENA IN THE SKIN OF FROG.—Engelmann (*Pflüger's Archiv.* IV. 321—324) has continued his researches on the contractile glands of the frog's skin (see *Journal of Anat. and Phys.* May, 1871). The electro-motor properties of the frog's skin have long been known, but it struck Engelmann that possibly the currents were due to the contractile cells which form a special layer of the so-called epithelium of the glands. Numerous observations of the coincidence of variations in the electro-motor power, with changes in the appearance of the contractile cells, have convinced him that these cells are the only source of the cutaneous currents of the frog. These electro-motive properties stand in intimate relation to secretion. He regards the process of secretion in these glands as nothing more than electrical osmosis. The direction of the current, though at first sight contrary to the course of secretion, is readily explained by the position of the cells, the current passing in their case, as in muscle, from the longitudinal to the transverse section.

CONTRACTILITY OF WHITE CORPUSCLES.—Hoppe-Seyler (*Med. Chem. Untersuch.* p. 486) finds that white blood or lymph corpuscles contain glycogen so long as they exhibit movements, but when they become rigid they lose their glycogen and contain sugar. In the pus from abscesses and wounds no glycogen was found, and the occurrence of glycogen may, therefore, be taken as a means of distinguishing lymph from pus corpuscle, although the latter spring from the former.

ACTION OF SEA WATER ON FRESH-WATER ANIMALS.—P. Bert (*Comptes Rendus*, LXXIII. 382—5, 464—7) investigates the cause of death when fresh-water animals are placed in sea water. Fresh-water animals placed in salt water of a temperature of 15° to 16° C. die after some minutes or hours, according to the species. Fresh-water animals may, to a certain extent, be acclimatised to salt water by gradual addition of the latter, but they invariably die when the proportion of salt water is more than one half. Experiments with the individual constituents of sea water proved that the fatal effect is chiefly due to the chlorides. The cause of death is exosmotic dessication. In animals breathing by gills the immediate cause of death appears to be sudden arrest of the branchial circulation. The more delicate the structure of the gills the more rapid the effect.

ACTION OF FRESH AND SALT WATER ON ANIMAL LIFE.—In a series of experiments, F. Plateau (*Mém. de la Soc. Roy. Belg.* XXXVI. and *Academy*, 311) found that the fatal effects of sea water on fresh-water species of articulata, and of fresh water on marine species, are due to differences in chemical composition and not in density, as fresh-water species lived perfectly well in a solution of sugar of the density of sea water. The poisonous action of sea water is due to the chlorides of potassium, sodium, and magnesium, while the sulphates of magnesium and calcium have little or no effect. The sulphates are hardly absorbed at all, but the chlorides are rapidly absorbed, and if the animals are placed in distilled water, are again given out. When marine articulata are placed in fresh water, they give off chloride of sodium, and the loss of this Plateau believes to be the cause of their death.

CAUSE OF PHOSPHORESCENCE.—Panceri (see *Academy*, p. 401) thinks phosphorescence is due to the slow oxidation of fat. In fishes oxygen penetrates the skin and oxidizes the fat below. It is increased by oxygen, but stopped by immersion in carbonic acid, fresh water, alcohol, or any substance not containing oxygen. Phosphorescence begins at death and stops when putrefaction begins.

EXPERIMENTS IN PANGENESIS.—In a series of experiments which he made in order to test the truth of Darwin's theory of Pangenesis, Galton (*Proc. R. S.* p. 394) injected the blood of other kinds into the veins of pure silver-grey rabbits and then bred from them. If granules were present in the blood, and the sexual elements consisted simply of organized groups of these granules, the offspring of these rabbits ought to have presented some of the characters of the other breed from which blood had been transfused into the parent animals, in addition to their own natural ones. His experiments consisted of, 1st. Moderate transfusion of partially defibrinized blood. 2. A large transfusion of wholly defibrinized blood. In both these cases a quantity of blood similar to that injected was previously drawn from the vein. 3. Establishing a system of cross circulation between the carotid artery of a silver-grey and of a common rabbit. The injection of blood sometimes produced temporary sterility, but had no effect on the offspring, which exactly resembled their parents, except in one doubtful case. Cross circulation had no effect whatever. This shows that the reproductive granules are not independent residents in the blood, though it is possible that they may be temporarily present in it.

REPRODUCTION OF EPITHELIUM.—Heiberg (*Stricker's Medicin. Jahrb.* Heft I. p. 7) finds that when the epithelium is scraped off the surface of the cornea in the frog, fowl, or rat, it is reproduced only at the edges of the denuded part, and never from any isolated centre on its surface. The isolated centres from which reproduction of the epithelium of denuded skin takes place are, he thinks, gland-ducts lined with epithelium. He considers that the abraded epithelium is reproduced in the cornea by cells at the margin of the denuded spot sending out processes in which a transparent spot appears. The processes then separate from the parent and develope into new cells, the spot becoming the nucleus, and then in their turn send off new cells which gradually cover the bare spot.

ORIGIN AND DISTRIBUTION OF SUGAR-FORMING FERMENT.—Lepine (Ludwig's *Arbeiten*, 1871, p. 113) finds that starch is converted into sugar in half-an-hour or an hour by pieces of the mucous membrane from the tongue or palate of the frog, or by the fluid which covers their surface. The fluid can be obtained by means of small pieces of satin-paper laid on the tongue. The mechanical irritation which these produce cause the tongue to become red and the fluid to be secreted so plentifully that it may be removed by means of a glass rod. The secretion can also be stimulated by electrical irritation of the hypoglossal and glossopharyngeal nerves and of the tongue itself. When it is examined microscopically, after its nerves have been irritated some time, numerous lymph-cells are found in the neighbourhood of the racemose glands which are contained in it, and which may be regarded as salivary glands. A sugar-forming ferment has been found by other authors in the mucous membrane of the stomach, intestine and bladder, liver, bile, kidney, brain and muscles; but he obtains it besides in dogs, rabbits, and frogs, from the spleen, lungs, testicles, tendons, serous membranes, cornea, and vitreous humour, from both the inner and outer surfaces of the frog's skin, the mucus of its ovary and that covering the slug. It does not exist in equal quantities in all organs, but the only place where it was absent was the crystalline lens. It diffuses through vegetable parchment. Human saliva, unlike that of the dog, does not become more powerful by standing. In accordance with Bernard's statement he finds that a sugar-forming ferment is produced during the decomposition of albuminous substances, the crystalline lens included.

ON THE EVOLUTION OF AMMONIA FROM PUTREFYING BLOOD.—Exner (*Wien. Acad. Bericht*, 1870, B. LXII. 2 Abth. S.A.) has studied the influence of atmospheric air, and specially of oxygen, on the process of putrefaction of blood with particular reference to the observations he had already made that access of oxygen favours the evolution of ammonia. When atmospheric air was passed through blood contained in a wide-mouthed vessel, for two or three days, an intense evolution of ammonia took place and the blood-colouring matter was set free. He shews that the evolution of the ammonia is not due to the discharge of the colouring matter. When equal portions of blood were placed under different degrees of pressure, the evolution of ammonia was greater under the higher pressure. In order to determine whether the organisms contained in the atmosphere played any part in the formation of ammonia, he passed into the blood air filtered through cotton wool or nitric acid, and found that the effect was in nowise modified.

Experiments as to which gas the evolution of the ammonia was due, proved that pure nitrogen and also carbonic acid which Pasteur regards as necessary for fermentation, had no effect, and that pure oxygen had no more energetic effect than ordinary air. When blood was treated with hydrogen the evolution of ammonia was greater than under the action of nitrogen, but less than that caused by air. When a quantity of blood was sealed up from access of air, an evolution of ammonia was observed when the vessel was continually shaken. In a similar vessel allowed to remain perfectly at rest no ammonia could be detected. In all cases and in all fluids experimented with, low organisms, such as bacteria, vibriones, &c. were found.

PRODUCT OF BILIARY PIGMENT.—Stockvis (*Maandblad der sectie voor Natuurwetenschappen*, 1870, No. 305) has observed that the presence of bile-pigment in icteric urine can be recognised by its becoming of a brownish green colour, and presenting peculiar spectroscopic absorption-bands after it has been treated with chloride of zinc and ammonia and exposed to the air. The same absorption-bands are presented by biliverdine after treatment with chloride of zinc and ammonia or by blifuscine (?) which has been exposed to the air for 2—4 days. During the preparation of biliverdine from bilirubine through the action of chloride of zinc and alkalis, bilifuscine or some substance nearly allied to it probably occurs as an intermediate product. When it is treated with acids the substance appears to yield biliverdine, and a peculiar colouring matter soluble in water. This peculiar brownish green or green colouring matter is an oxidation product of bile-pigment and nearly allied to those which occur in Gmelin's reaction.

FLUORESCING PRODUCT OF THE REDUCTION OF BLOOD-COLOURING MATTER.—Stockvis (*Maandblad der sectie voor Natuurwetenschappen*, 1871, No. 9) has obtained a peculiar rose-coloured, fluorescing substance by boiling a solution of dried blood, hæmoglobin, hæmatin or hæmatoin in alcohol with hydrochloric acid and tin, diluting the product, and treating it with ether chloroform or amylic alcohol. He has not obtained it in a crystalline condition. It presents peculiar spectroscopic absorption bands which are quite distinct from those of iron-file hæmatin though slightly resembling them. It resembles bile pigments in its fluorescence, in the alterations produced in its spectrum by mineral acids, and in its solubility in either alcohol and amylic alcohol. He has not been able to oxidize or reduce it.

A NEW SCHEMA OF THE CIRCULATION. By WM. RUTHERFORD, M.D. F.R.S.E. *Professor of Physiology, King's College, London.*

MUCH may be learned regarding the circulation with the aid of Weber and Marey's Models. Weber's Model or Schema is a simple elastic tube (formerly a piece of intestine), at one part of which two membranous valves are fixed so as to represent the valves of a cardiac ventricle; at another part of the tube a piece of glass tubing containing a sponge is inserted; the pores of the sponge representing the capillaries. By means of this model the student can readily understand why the blood moves in a certain direction, and he can also learn a good deal regarding the blood-pressure. The Schema constructed by Marey is more elaborate and is capable of shewing a good deal more. It consists of a system of elastic tubes arranged so as to represent the Arterial System. There are no veins or capillaries, and as the apparatus is worked the water which is driven through the tubes pours out by the arterial orifices. The water pours from these into a glass funnel which transmits it into the auricle of the heart. Manometers and sphygmographs can be adapted to the arteries, and numerous important lessons can be learned from the employment of these. The apparatus, although ingenious, is nevertheless very incomplete, and inasmuch as it must always be kept in a vertical position, it is inconvenient. I have recently had constructed a Schema of the circulation, which serves to shew all that Weber and Marey's models exhibit, and a great deal more. I therefore think it worth while to direct the attention of physiologists to it, for I find it of the greatest service for teaching purposes; and it will, I think, enable us to arrive experimentally at several important facts regarding the circulation. I am at present working at this subject, and feel warranted in making the above statements.

The figure that I give below looks somewhat formidable. At first glance the reader will probably regard the Schema as labyrinthic enough, but the complication will quickly disappear. I have represented it in connection with various instruments which may be used for studying blood-pressure and motion.

Presuming that the reader has perused the description of the above figure, I will simply say that the tubes of the apparatus consist of vulcanised India-rubber. Those representing the arteries are thick and strong, and do not collapse when empty. Those representing the veins have thinner walls, a larger calibre, and, unlike the arteries, they collapse when empty. The ventricle of the heart consists of an ordinary elastic pump. One with leaden balls does perfectly for illustrating all the facts regarding the blood-pressure, the abolition of the pulse-wave by the capillaries &c., but for sphygmographic and sphygmoscopic tracings valves consisting of balls do not suffice, inasmuch as they give tracings very different from those which are obtained from human vascular system. Valves

(S) may be employed, and its tracings recorded upon a revolving cylinder. Marey's Sphygmoscope S′, or Fick's Feder-Manometer, may be connected with another, or it may be the same tube, and the tracings produced by them may be recorded upon the same cylinder with the sphygmographic, and also the kymographic (manometer) tracings. Most valuable comparisons can thus be instituted between the tracings produced by these various instruments. Ludwig's Hæmometer or Stromuhr (S″) can be attached to another, or it might be the same tube as the sphygmograph or manometer; and the volume of fluid that flows through the tube in a given time can thus be compared with the pressure, &c. Chauveau's Hæmodromometer or Tachometer may also be inserted, and the speed of the current compared with the pressure, &c.

The effect upon the current of causing it to pass through tubes of different calibres, tubes which have constrictions or dilatations, tubes which divide at acute or obtuse angles, &c. may be investigated. All these, and many other things, may be readily studied with the aid of this apparatus. The tubes K K′ K″ can be opened, if other tubes are needed. When the apparatus connected with the tubes l and l′ is not used, the tubes are clamped or tied and the piece of tubing added, taken away from a short stump of tubing (like that at K′ and K″) left in connection with the proper vessel of the Schema. Junctions of tubes are made by placing a little piece of glass tubing within the adjoining orifices of the ends of the tubes, and these are of course tied firmly upon the glass tubes.

This apparatus is valuable to the student as well as to the teacher, for by handling it for himself, the student can readily gain a knowledge of the circulation, which books can never enable him to obtain.

The India-rubber part of the Schema has been cheaply and satisfactorily constructed for me by the North British India-Rubber Company, Canon-mills, Edinburgh, from whom it can at any time be obtained.

Journal of Anatomy and Physiology.

THE MUSCLES OF LEPIDOSIREN ANNECTENS, WITH THE CRANIAL NERVES. By PROFESSOR HUMPHRY. (Pl. XII. Figs. 23 to 27:)

THE muscular system of Lepidosiren presents[1], as might be expected, many interesting features of an intermediate condition between that of the Fish and that of the Urodelan.

The great lateral muscle, as in those animals, is divided by a lateral septum passing, from before backwards, nearly midway between the dorsal and the ventral edges, into an upper or 'dorsal' and a lower or 'ventral' muscle. Each of these is also subdivided into myotomes by transverse fascial inscriptions or 'intermuscular septa' which are more simply disposed than in most Fishes, forasmuch as they run from the lateral septum, in nearly straight lines or with a slight anterior curve, upwards and downwards, to the dorsal and ventral edges. Traced, from the external fascia, into the substance of the dorsal muscle the septa pass, in oblique planes, forwards and inwards to the dorsal spines and the fin-rays; and those in the ventral muscle pass also obliquely forwards and inwards, to the ribs, hæmal spines, and fin-rays, where these exist, or to the internal surface of the ventral cavity and there blend with the internal or transversalis fascia.

FASCIAL INVESTMENT.

The EXTERNAL or SUBCUTANEOUS FASCIA covering the lateral muscle is not, as in Cryptobranch, loose, permitting movement of the skin upon the muscle, but, as in Fishes though not quite in the same degree, compact and closely united with the derma on the one side and with the intermuscular septa on the other. It is separated from the skin by a thin stratum of pigmentary areolar tissue; and its union with the intermuscular septa is still more close. Hence it is with difficulty dissected off as a continuous sheet. Forasmuch as all, or nearly all, the fibres of the lateral muscle terminate in and arise from the septa, they are, through the medium of the septa, brought into relation with one another, with the vertebral system on the one side, and with the dermal system on the other. This is an important point; and the continuity of the parts or layers of the outer wall of an animal body thus established must be borne in mind in considering the relations of the muscles, and their subdivisions, to one another and to the dermal and vertebral systems.

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[1] The specimen of Lepidosiren Annectens from which these notes were taken was nineteen inches in length. It was dissected chiefly by Mr Anningson, partly by myself.

Along each edge (upper and lower) of the animal, in the forepart, where the mesial fin is absent, the fascia of either side blends with that of the opposite side and is intimately united with the cutis externally. The median sheet resulting from the blending dips between the lateral muscles of the two sides. The upper one impinges upon and unites with the dorsal spines and other vertebral elements; and the lower blends with the hæmal spines or with the fascia transversalis.

In the region of the mesial fin (dorsal, caudal, subcaudal and anal, for they are continuous) the disposition is somewhat different. At the base of the fin the fascia on each side divides into two laminæ (Fig. 23 *B*). Of these one, superficial or subcutaneous, accompanies the derma upon the fin and is lost with it on the delicate horny fibres of the fin. The other lamina, retaining its connection with the lateral muscle, passes over the edge of that muscle, between it and the fin covered by its fin-muscle, and so reaches the neural or hæmal spines and the fin-rays resting upon them. It here becomes blended with those spines as well as with the intermuscular septa which are here passing into the spines and fin-rays. Thus the fin with its muscles is enclosed in the interval between the superficial and deep fascial laminæ of the two sides, in the same manner as the dorsal, ventral and lateral fat masses in Cryptobranch (p. 5). There is however this difference, that the fat masses in Cryptobranch occupy continuous channels which are not broken or subdivided by the transverse septa extending into or across them; whereas the channel for the mesial fin of Lepidosiren is, in the line of each fin-ray, interrupted by the transverse septa of the lateral muscles of the two sides, extending through and transversely subdividing the fin-muscles and joining and blending with the fin-ray. The same disposition is observable in other fishes and is illustrated by Ceratodus (see p. 281). In the case of the pectoral and ventral fins the fascia is continued beneath the skin upon the muscular covering of the fins.

The INTERNAL or 'TRANSVERSALIS' FASCIA, lining the abdominal space and closely applied to the ribs, is distinct and strong. It is particularly strong in the region corresponding with that of the *depressores costarum* of other animals. A thin layer of it bends inwards upon the œsophagus, behind the pericardium, forming a rudimentary post-cardiac diaphragm. The fascia itself, or the greater part of the thickness of it, passes upon and is closely connected with the pericardium, and is, with the pericardium, attached strongly to the hinder and inner surface of the coracoid arch inferiorly. Superiorly it is thinner, and is accompanied upon the front of the pericardium by a distinct detachment of fibres from the internal surface of the ventral muscle, which thus forms a precardiac or post-branchial musculo-fascial diaphragm. Internally, the transversalis fascia is, in the greater part of its extent, in contact with the peritoneum. Externally, it lines the ventral muscle and is connected with the external fascia by the intermuscular septa passing obliquely between them. Inferiorly, it passes beneath the edge of the ventral muscle and blends, as just stated, with the external fascia. Behind the pelvis it forms a sheath upon the bowel passing to the anus. (Fig. 23, *G*.)

THE VENTRAL MUSCLE

presents nothing remarkable in the tail.

In the abdominal region, in about the middle third of the space between the lateral septum and the ventral mesial line (Fig. 23), the fibres of the outer stratum present a slight but distinct obliquity, from before backwards and *down*wards (towards the mesial line), as they pass between the several septa. This disposition to the formation of an *obliquus externus* muscle is most marked in the middle of the space indicated. It diminishes above and below; and in the third of the muscle next the lateral septum, as well as in the third next the mesial line, the fibres are '*recti*.' The removal of the superficial—external oblique —stratum shews an obliquity, to a like degree, but in a different direction, in the subjacent stratum. (Fig. 23 *A*.) The fibres there pass from before backwards and *up*wards (towards the lateral septum) and form an *obliquus internus*. In this instance also the oblique direction disappears in the upper and lower thirds of the muscle. The fibres there run antero-posteriorly, and the tendency to division into planes is lost. This gentle effort, as it were, at the formation of oblique muscles is an interesting corroboration of the remarks made (p. 11) with reference to the cleavage of these muscles in Cryptobranch, exhibiting as it does a still lower grade of stratification than we found in that animal. (See also Ceratodus, p. 280.) There is no appearance of a third or *transversalis* stratum; and there are no muscular fibres in a deeper plane than the ribs. This is also the case in most Fishes, though in some (Bream and Dace) there is a thin muscular layer beneath the level of the ribs; and the nerves lie upon its outer surface.

In describing the external fascia, I have mentioned that a superficial layer of it is continued upon the exterior of the mesial fin and that another layer passes beneath it; so that the rays and muscles of the fin are enclosed between the two layers and are separated from the lateral muscle by the deeper of them: also that the intermuscular septa are continued into the fin and blend with the rays, so causing a transverse segmentation of the fin. The fin-muscles are contained in the fascial partitions thus made, and consist of a layer of fibres parallel with the fin-rays, resting with one end upon the lateral muscle, or rather upon the fascia which separates them from it, and with the other end expanded upon the fin. The greater number of the fibres arise from and lie along the lines of the septa and the rays, as shewn in Fig. 23, where the alternating thicker and thinner parts of the muscle thus produced are well displayed, and the thicker parts are seen to be in or near the lines of the septa of the lateral muscle and of the fin-rays. Now, the septa are disposed with regard to the fibres in the same way as they are with regard to the lateral muscle; and they connect the divisions of the fin-muscle with one another, and with the lateral muscle, much in the same way that they connect the several divisions of the lateral muscle itself. The chief difference consists in the direction of the fibres of the fin-muscle, which is at right angles, or nearly so, to that of the fibres of the lateral muscle. This causes the one series to be segmented from the other; and the action of the two being distinct leads to their being further separated by the fascial layer passing between them. At the forepart of the dorsal fin the fibres of the fin-muscle extend a short distance, on either side, upon the surface of the lateral muscle between the two layers of fascia. They do this more widely in some Fishes, becoming thus subcutaneously expanded upon the dorsal muscle; and they are still more segmented from it[1].

The relations of the ventral muscle to the ventral-fin are simple and interesting. The chief part of the muscular fibres of the fin are derived from the slanting postero-lateral edge of the pelvis[2], above and below the acetabulum, and indeed all round the joint. These (Fig. 23 *E*) descend upon the whole circumference of the fin, ensheathing it and blending with the fascial tissue beneath the skin and with the fibrous perichondrial tissue which invests and unites the series of cartilaginous pieces that form the cylindrical tapering skeleton of the fin. To these are superadded fibres from the adjacent part of the ventral

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[1] See, further, the description of the relation of the fin-muscles to the lateral muscle in Ceratodus (p. 280).

[2] The pelvis is of somewhat diamond shape. The posterior angle is prolonged slightly into an obtusely pointed process. The anterior angle runs forwards as a smooth styliform process, an inch and a half long, and occupies a channel in the fascia formed in the same manner as the channel for the mesial fin above described, a circumstance which is not a little confirmatory of the view I have expressed (*Journ. of Anat.* v. 59) respecting the serial homologous relations of the mesial and lateral fins. The lateral angles of the diamond run out into horn-like processes, and are connected with or continued into the transverse septa of the lateral muscles on the two sides. Near the hinder part of the cartilage, on either side, is the articular facet for the first cartilage of the fin. See Fig. 23.

In Owen's Memoir, *Linn. Trans.* XVIII. Tab. 23, as well as in the *Anat. Vert.* I. Fig. 47, the pelvis is represented and described with the styliform process directed backwards.

muscle, which converge from before and from behind and blend with them. There is no line of demarcation between the fibres derived from the pelvis and those derived from the ventral muscle. Some of the latter proceed from the next adjacent septa before and behind; and some are derived from more distant septa. As represented in Fig. 23, the lowest and hindmost of the ventral fibres passing upon the fin are segmented from the rest of the ventral muscle and are uninterrupted by septa for a greater distance than those situated higher up. Between the converging bundles from before and behind is seen an interval (*F*) in which the nerves run, from beneath the edge of the ventral muscle, over the outer edge of the pelvis and the acetabular joint, upon the fin.

As it approaches the forepart of the animal, the ventral muscle (and this will be found to be the case also with the dorsal muscle) gives off a superficial stratum which is thin and partly membranous (Figs. 24 and 26). Its disposition is as follows: it separates from the deeper stratum of the ventral muscle a little behind the level of the pectoral fin, at one of the septa, and is thenceforward connected with the deep stratum only by loose areolar tissue; so that it is easily dissected away. This is especially the case near the middle line. It retains the transverse septa and, advancing forwards, expands as a continuous sheet upon the shoulder-girdle and the hinder aspect of the base of the fin. It is also continued forwards upon the lower jaw, the gill cover and the opercular bones; and it spreads in this direction upon the surface of the dorsal muscle, becoming blended with the fascia of that muscle and so reaching the dorsal median line. It may be called the SUPERFICIAL BRACHIO-CEPHALIC STRATUM of the ventral muscle, to distinguish it from the deeper stratum of the same muscle which also passes to the limb-girdle, limb and head, and which may be called the DEEP BRACHIO-CEPHALIC STRATUM.

The upper portion (*L. d.*) of this superficial brachio-cephalic stratum—the portion, that is, nearest to the lateral septum,—a little in front of the line of separation from the deep stratum, is inserted into the upper, or scapular, part of the shoulder-girdle, which forms a conical projection above the fin, and into the upper part of the first cartilage of the fin, which may be regarded as representing the upper or humeral segment of the forelimb of higher animals. Some of the fibres also blend with the other muscles of the fin. This portion of the stratum represents, therefore, the *latissimus dorsi.*

The next portion (*P*) of the stratum, a little more ventrally situated, is attached to the under-surface of the fin and its first cartilage, and to the anterior edge of the shoulder-girdle (the coracoid) beneath the fin. The coracoid is here covered by an extension of the mucous membrane of the branchial chamber, and contributes to form the wall of the branchial passage, and of the slit-like branchial opening; and the mucous membrane extends a short distance upon the surface of the muscle which accordingly contributes, with the coracoid, to form the hinder wall of the passage leading to the branchial chamber. This portion of the stratum corresponds with the *pectoralis major.* It is really continuous with the *latissimus dorsi:* but the fibres establishing the continuity between the two, and attached to the girdle and the fin in the immediate neighbourhood of the glenoid cavity, form a very thin sheet; and an axillary interval is easily made between the pectoral and the latissimus dorsi portions of the stratum.

Still more ventrally or mesially, the fibres of the superficial brachio-cephalic stratum pass onwards and form a superficial cervical muscle (*cervicalis superficialis*). The lateral fibres run beneath and in front of the branchial opening; and, covered by the skin externally and lined by the mucous membrane internally, they form the margin of the gill cover and the anterior wall of the passage leading to the branchial chamber. They (Fig. 24, *Sp. br.*) moreover spread out over the branchial chamber and, in front, come into contact with and are attached to the opercular bones[1] and the side of the skull; while, above,

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[1] There are distinctly two opercular bones as represented by Peters. One, the inferior or *suboperculum*, situated behind the angle of the mandible, is triangular, with its apex directed forwards and continued into a narrow tendon which is attached to the inner surface of the lower part of the dentary bone, about the middle; and it blends there with the fibres of the mylo-hyoid muscle. The other, the superior bone or *operculum*, is smaller, more elongated, and extends up between the preceding and the hinder surface of the suspensorium.

Owen (p. 336) mentions only the superior. Huxley, *Anatomy of Vertebrate Animals*, p. 170, mentions the superior as operculum and the inferior as a 'branchiostegal ray' carried upon the hyoidean arch. It is however connected they arch over the branchial opening and radiate into the fascial tissue covering the dorsal muscle (Fig. 24, *Tr.*). Here the hindmost fibres, bending backwards, are inserted into the upper and anterior surface of the scapula above the fin; and some pass on into the fin. These returning fibres therefore meet the fibres of the *latissimus dorsi* advancing to the same part. They—so much of this part of the stratum as lies above the branchiæ—appear to represent the *trapezius*[1]; while the fibres lying below and upon the branchiæ, and advancing forwards to the skull, may be regarded as representing the *sterno-cleido-mastoid*[2]. Dissecting away the fibres which radiate upon the dorsal muscle, I find some beneath them, running below the level of the lateral septum and inserted into the supra-scapular bone, which is here deeply seated, also into the ligament which connects that bone with the scapula[3].

The dipping down of the deeper fibres of this layer, which I suppose to represent the *trapezius* and *sterno-mastoid* among other muscles, towards the cervical transverse processes accords with the disposition of the *cervico-humeral* muscle in many mammals, and affords an explanation of that which has seemed to be an aberrant feature of this muscle, viz., that in its upper part it is in close relation with the *levator scapulæ* and might be thought to belong to it; whereas, below, it is in close relation with the *trapezius* and claims even more distinctly to appertain to it. It is further interesting to remark that in the Crocodile the *sterno-mastoid* runs to the cervical transverse processes; and a deep band of the *trapezius* does the same[4].

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with the lower jaw and the operculum rather than with the hyoid; and its opercular relations are confirmed by the disposition of the corresponding bone in Ceratodus. This is described as suboperculum by Günther in his excellent paper on the Ceratodus, *Phil. Trans.* 1871, p. 525.

[1] It is named *levator scapulæ* by Owen, but is too superficially placed for that muscle.

[2] These, at least, are the muscles which they chiefly represent. There are, however, other muscles in different animals which must be derived by segmentation from the same source, such as the *constrictor faucium, depressor mandibulæ, levator arcuum, subcutaneus colli*, from the superficial surface, and, more deeply, the *rhomboids, masto-scapular, cervico-humeral*, &c.

[3] This bone is quite distinct, as described by Peters. For further account of fibres, similar to those above mentioned, see description of Dog-fish (p. 274).

[4] In the Dog-fish (p. 274) all the fibres pass beneath the lateral septum, and none expand upon the dorsal muscle.

In that animal the several gill-openings cause a greater separation between the upper and lower parts of the muscle than is caused by the single transverse slit-like opening in Lepidosiren, and I have accordingly named the part above the gill-openings *cervicalis superficialis superior*, and the part below them *cervicalis superficialis inferior*.

The most ventral or mesial portion of the superficial brachiocephalic stratum, separating a little from the portion last described, passes beneath the floor of the mouth and is inserted along the inner and lower edge of the circle of the lower jaw, also strongly to the cornu of the hyoid[1], near the angle of the jaw, and less strongly along the upper edge of the cornu, and to the suboperculum. Here it is blended with the subopercular fibres of the last described (sterno-cleido-mastoid) portion. This portion of the stratum (Fig. 26, *M. h.* and *S. c.*) represents the *mylo-hyoid* with part of the *subcutaneus colli* or *platysma.* The transverse septa cease on a level with the angles of the jaw; and the fibres in front of that take a more transverse direction, are less closely connected with the skin, and are less stained with pigment than in the hinder regions of the stratum. The stratum is here, for a short distance, in two layers (Fig. 26, *S. c.* and *G. h.*). In the deeper of these, which is a more direct continuation of the superficial stratum of the ventral muscle, the fibres have an antero-posterior direction. It is inserted near the symphysis of the jaw only; and just behind the symphysis it is in immediate contact with the mucous membrane of the mouth, which is reflected upon it from the rudimentary hyoid and tongue and then passes from it to the symphysis. In the superficial layer (*S. c.*) the muscular fibres are more transverse, and are inserted into the ramus of the jaw and the cornu of the hyoid as well as into the symphysis. It is this superficial layer which more distinctly represents the *mylo-hyoid* and the *subcutaneus colli*, while the deeper layer (*G. h.*) may represent, in part, the *genio-hyoid*[2]; but the two layers are blended in front, near the symphysis, as well as behind at their junction with the septum of the ventral muscle from which they both spring.

It should be added that some of the fibres of the superficial layer, lying between those which I call *subcutaneus colli* and those which I call *mylo-hyoid,* radiate from, as well as are inserted into, the angle of the jaw and the adjacent cornu of the hyoid; and the fibres passing from the latter point, beneath the body of the jaw, to the symphysis form a hyo-mental (p. 325) and appear to represent the anterior belly of the *digastric* (Fig. 26, *D*).

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[1] The cerato-hyoid. There is no basi-hyoid.

[2] They are so named by Owen in the description of Figs. 4, 5, and 6.

The DEEP BRACHIO-CEPHALIC STRATUM of the VENTRAL MUSCLE (Fig. 26, *D. v.*), the part that is beneath the whole of the superficial stratum just described, is far thicker than it and is marked by septa in its whole length. In its course it encounters three bones in succession; each of which is in the line of one of its septa and is involved in it.

The first of these bones (Fig. 26, *R*) is a stout cylindrical elongated bone, articulated by a broad trochlear surface with the cartilage of the base of the skull just behind the opening for the vagus nerve, and running down into the substance of the lateral muscle. This bone in form, position and relation to a septum, resembles a rib; and it probably is to be regarded as a rib, although it is much larger than any of the succeeding ribs. This view is confirmed by the fact that a short thick muscle here separates itself from the rest of the deep stratum of the ventral muscle and passes from the bone in question to the under surface of the scapular part of the shoulder-girdle, representing pretty clearly the *serratus*[1]. The nerve to the fin takes its course beneath the edge of this muscle, between it and the muscles attached to the coracoid, holding therefore the same relation to it as the brachial nerves in other animals do to the *serratus*.

This deep stratum of the ventral muscle next comes into contact with the coracoid which is connected with one of its septa, much in the same manner as the ribs are connected with the septa of the ventral muscle, that is to say, the coracoid is an ossification in the deepest part of the septum. Many of the muscular fibres are inserted into it, representing the *costo-* and *sterno-coracoids* (the ribs and costal cartilages being represented by the septa behind the coracoid). The greater portion of the fibres, however, run beneath, superficial to, the coracoid on to the hyoid, constituting a deep cervical (*cervicalis profundus*) muscle (*C. p.*). Some of these are inserted, tendinous, into the hyoid near the middle line. Some terminate in a tendinous

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[1] I am glad to find that the view I have formed of this peculiar bone from its muscular relations in Lepidosiren is confirmed by Günther, in his description of the corresponding bone in Ceratodus, *Phil. Trans.* 1871, p. 529. Various views have been entertained of it, the last being that by Mr Parker (*Shoulder-girdle and Sternum*, p. 21, and Pl. II. Fig. 1), who regards it as a 'pharyngo-branchial' bone, and a small cartilage attached to its middle as a 'small unossified second pharyngo-branchial.'

band which is continued round the anterior part of the hyoid, near the middle line, and is inserted into the dense tissue there, in the place of a glosso-hyal, which causes a median elevation in the floor of the mouth, behind the symphysis of the jaw, and constitutes a rudimentary tongue. The more lateral fibres, curling beneath the coracoid, are folded over the median part of the muscle between the coracoid and the hyoid, giving a thick rounded edge to the muscle in this situation, and are inserted into the upper surface of the middle of the hyoid. The result of this disposition is a thick strong coraco- or ventro-hyoid, a representative of the sterno-hyoid, which serves powerfully to draw the hyoid backward, deepening the cavity of the mouth and raising the gill-cover. To some extent, therefore, it acts antagonistically to the superficial stratum, part of the office of which is to compress the opercular apparatus. It is disencumbered from other muscles by complete segmentation, and by an investment of loose areolar tissue, so as to be enabled to act freely and fully upon the hyoid.

The pharyngeal muscles of higher animals are represented, or partly represented, by a delicate layer of fibres—a *hyo-pharyngeus*—passing backwards from the hyoid, on either side of the mesial line, and radiating upon the mucous membrane of the pharynx. They meet and blend with a similar layer of fibres passing forwards from the coracoid and, in like manner, radiating upon the pharynx and the under-surface of the branchial chamber. These sub-mucous layers, specially segmented from the deep surface of the ventral muscle, resemble and are derived in the same manner as the subcutaneous layers which are specially segmented from its superficial surface, and which constitute the *platysma* and the *panniculus carnosus* of Mammals.

A short strong fan-shaped muscle—*stylo-hyoid*—radiates from inner surface of the hyoid[1], near its upper end, to the under surface of the back part of the suspensorium, behind the auditory capsule, where it has a broad insertion.

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[1] The hyoid (cerato-hyoid) rests upon the auditory cartilage, and is connected with the base of the skull by a tough ligament, and with the inner side of the angle of the jaw by a strong stylo-, or better, hyo-maxillary ligament.

DORSAL MUSCLE.

The superficial stratum of the dorsal muscle, separating in the same manner and nearly at the same part of the animal as that of the ventral muscle, soon becomes in great part membranous, passes over the side of the head, and is attached to the end of the suspensorium just above the glenoid cavity, to the lower jaw a little in front of its angle, to the tooth-like hinder projection of the maxillary bone and to the edges of the pre-maxillary and frontal bones[1]. It represents the *temporal fascia;* and muscular fibres are attached to or detached from both its surfaces. Those which are connected with its superficial surface are continued into, or are more or less connected with, the superficial stratum of the ventral muscle. It is thus connected with the muscles already described as representatives of the *trapezius* and *sterno-mastoid;* also with the two following muscles situated in front of those last-mentioned and, like them, appertaining rather to the superficial ventral stratum; though their description is more conveniently given here.

These two muscles are superficial and thin, and lie upon the extension of the dorsal fascia to the suspensorium and mandible. They are separated from one another only by a fascial line from which the fibres of both arise; so that they might be regarded as one. The hinder of the two, which I will call *levator operculi* (Fig. 24, *L. o.*), radiates, from the angle of the mandible and the fascial line just alluded to, backwards upon the superior opercular bone and the interval between the two opercular bones where it blends with the pre-branchial (sterno-cleido-mastoid) part (*Sp. br.*) of the ventral muscle. The anterior of the two muscles (Fig. 24, *D. m.*) is also attached to the angle of the mandible, to the fascial line and to the suspensorium. Its fibres are directed more forwards upon the dorsal fascia. Its position is not unlike that of the masseter; but the masseter is represented by another muscle. On the whole, it rather corresponds with the *depressor mandibulæ*, or with that portion of it which, in some animals, arises from the suspensorium; while the portion which, in Cryptobranch and many others, arises from the dorsal fascia and the cervical spines is probably represented, in Lepidosiren, by some of the fibres of the levator operculi and of the supra-branchial (trapezius) muscles.

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[1] Müller (s. 245 and Tab. VI.) describes in Bdellostoma a similar extension of the dorsal muscle forwards over the side of the head to the tentacles. It was connected by a ligament with the hyoid and the upper part of the skull.

One or two points deserve attention here. *First*, the mode in which the superficial and the deep strata of the dorsal and of the ventral muscle are blended, rendering it difficult or impossible to say where the one begins and the other ends, or to refer precisely the respective muscles to the one or the other. This blending seems, on the whole, to result from an extension of the ventral upon the dorsal stratum; and we find the same thing often occurring, behind the fore limb, in the spreading of the latissimus dorsi towards, or to, the vertebral spines. *Secondly*, the superficial and the deep strata, ventral and dorsal, are blended respectively in the ventral and dorsal muscles behind; both strata may contribute to the formation of the same muscle, as we shall presently find in the case of the temporal muscle. *Thirdly*, the superficial pre- and supra-branchial stratum which we have been considering as a derivative chiefly from the ventral muscle, presents itself in Lepidosiren in a simple, but from its connections very suggestive form, warranting, I think, the view I have taken that it is the representative, not only of the *trapezius* and *sterno-mastoid*, but of the numerous other muscles segmented in different ways in different animals, and passing upon the shoulder, the neck, the branchial apparatus and the jaw, so as to meet their varied requirements. *Fourthly*, it is interesting to note, in connection with the relation of the superficial strata of the lateral muscle in other parts and other animals to the so-called membrane bones, that the superficial stratum of the dorsal muscle is in Lepidosiren blended with the periosteum of the membrane bones of the upper and anterior regions of the skull. Further, some of these bones partially enclose the eye and form the orbit, from which, or its periosteum, the muscles of the eye arise. The ocular muscles in Lepidosiren surround the optic nerve. They may be clearly distinguished as four *recti* muscles of which the external is the largest; they are distinctly traceable to the periosteum in which, as just said, the dorsal stratum ends; and they are thus brought into continuity with the superficial stratum of the dorsal muscle and shewn to be derivatives from, or prolongations of, this part of the great lateral muscle.

The reflection of the superficial stratum brings into view the DEEP DORSAL STRATUM which is thick and composed of fibres passing forwards to the skull. A partially segmented conical portion of it, commencing about the third vertebra, and expanding as it advances forwards, forms the *temporal* muscle (Fig. 25, *T*). It passes over the suspensorium, filling up the lateral concavity of the skull. It is covered by the superficial stratum (the temporal fascia), as well as by the overhanging cranial bones into which that stratum is inserted. It derives a large accession of fibres from these structures which form its covering, as well as from the parts of the skull upon which it lies. It constitutes the hinder wall of the orbital space; and its fibres converge to be inserted into the coronoid process of the mandible, which is well developed, rising up behind the dentary plates that cover the forepart of the edge of the jaw.

The large size and extensive attachments of this muscle correspond with the thickness of the mandible, with the secure mode in which it is articulated with the skull and with the strong dentary plates which it carries. Its relation to the dorsal muscle, foreshadowed in Cryptobranch (Pl. IV. Fig. 20), and clearly made out in Lepidosiren, is of great interest as establishing the direct continuity of the muscles of the jaw with the lateral muscle.

The under surface of the temporal muscle, at and in front of the suspensorium, is confluent with the *masseter*. The division between the two is, however, indicated by the passage of the branches of the third division of the 5th nerve; and the latter muscle, though really a continuation of the temporal, may be described as arising from the forepart of the suspensorium and the inner surface of the temporal fascia; and it is inserted into the outer side of the coronoid process, beneath the temporal muscle, and into the outer side of the jaw near the coronoid.

Muscular fibres, arising from the forepart of the coronoid process, and partly continuous with those of the temporal muscle, radiate forwards upon the mucous membrane of the mouth, beneath the *retractor anguli oris*, and constitute a *buccinator*.

A stout *retractor anguli oris* (Figs. 24 and 25, *R. a. o.*) arises from the extremity of the suspensorium and the adjacent inner surface of the temporal fascia, also by a strong tendon from the outer side of the mandible in front of the angle. It is lost in the tough tissue about the angle of the mouth. It appears to represent in part the *depressor anguli oris* and perhaps the *Zygomatici*.

CEREBRAL NERVES. (Fig. 27, also Fig. 25.)

I subjoin a short account of the cerebral nerves of Lepidosiren, dissected by Mr Anningson.

The OPTIC nerve emerges from a small foramen in the forepart of the side of the skull beneath the frontal bone. It is accompanied and surrounded by the four *recti* muscles. Special nerves to these muscles (the third, fourth, and sixth) were not found.

The FIFTH nerve passes, in three divisions, through three foramina situated in the cartilage forming the anterior wall of the skull beneath the edge of the squamous bone.

The uppermost or OPHTHALMIC division (*Ophth.*) passes, deep, along the inner wall of the orbit, crosses over the optic nerve, gives off ciliary and oculo-motor nerves, and divides into three branches at least. One (*fronto-nasal, f. n.*) is joined by a branch from the supra-maxillary, and is distributed upon the inner side of the nasal process of the skull, upon the surface of that process, and upon the adjacent part of the head. A second branch (*nasal, n.*) traverses the inner wall of the orbit to the nasal cavity. A third branch reaches the floor of the orbit and unites with a branch of the supra-maxillary to form the *infra-orbital* nerve (*i. o.*) which is distributed in the upper lip.

The SUPRA-MAXILLARY division (*S. m.*) gives off three chief branches, a 'fronto-nasal,' an 'infra-orbital' and a 'muscular.' The *fronto-nasal* (*f. n′.*) pierces the upper part of the temporal muscle (Fig. 25 *f. n′.*), and runs upon its surface, beneath the temporal fascia and beneath the edge of the fronto-nasal process. There it joins the fronto-nasal branch of the ophthalmic division. The second or *infra-orbital* branch (*i. o′.*) runs beneath the maxilla just in front of the orbit and joins the infra-orbital branch of the ophthalmic. The third, or *muscular*[1] branch (*t.*) passes into and is lost in the temporal and masseter muscles, and appears to be the only nerve to those muscles; at least no branches could be traced into them from the next division.

The INFRA-MAXILLARY division escapes from the skull in two branches separated by membrane but traversing one foramen. One of these gives off a *nasal* nerve (*n′.*) which pierces the temporal muscle and runs beneath the temporal fascia (Fig. 25 *n′.*), passes to the nose, partly joins the nasal branch of the ophthalmic and is partly distributed to the cheek. This branch gives off a buccal nerve (Figs. 25 and 27 *b.*) which is also distributed to the cheek. The other, or mandibular, branch (*m.*) of this division is the larger of the two. It inclines downwards and forwards, passes over the upper edge of the mandible, between its coronoid and articular parts, runs beneath the strong external ligament of the joint and between the temporal and masseter muscles. Having gained the outer surface of the jaw it divides into three nerves. Two of these (Figs. 25 and 27 *l.*) are labial branches supplying the integuments on the exterior of the jaw and lip; and the third penetrates the jaw between the dentary and the articular parts.

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[1] This muscular branch, as well as the infra-orbital, is in Cryptobranch derived from the infra-maxillary (p. 46).

The SEVENTH nerve traverses a hole in the cartilage on the under surface of the skull, near the forepart of the suspensorium, in front of the origin of the stylo-hyoid muscle. It runs outwards between that muscle and the skull, gives off branches to the stylo-hyoid and to the muscles upon the opercular bones. One large branch (7′) passes forwards between the suspensorial cartilage and the squamous bone, meets the labial branch of the infra-maxillary, accompanies it over the edge and upon the outer surface of the mandible, and blends with one of the branches of it going to the lower lip. Another large branch (7″) passes beneath the suspensorium, supplies the depressor mandibulæ, perforates the strong stylo-maxillary ligament, and runs external to the ligament connecting the inferior opercular bone with the mandible. It continues its course under the shelter of the dentary bone, close to the mucous membrane, between it and the mylo-hyoid. Finally (7‴), it pierces the mylo-hyoid, curls over the edge of the jaw, and blends with the lower of the two infra-maxillary branches to the lip.

Peters represents this as the third division of the 5th. Its foramen is in front of the usual position. Still it is quite beneath the skull; its branches are distributed much in the same manner as those of the seventh nerve in Cryptobranch (p. 46), and the three divisions of the 5th are quite distinct in Lepidosiren.

The blending of the branches of the several divisions of the fifth with one another, and of the branches of the infra-maxillary division with those of the seventh—their imperfect isolation—is of much interest, in connection with the want of isolation of the oculo-motor nerves in these animals. It is also interesting in relation to the union which in ourselves is established between the supra- and infra-maxillaries and the seventh through the medium of the corda typani and other petrosal nerves. The object, whatever it may be, which is attained by the blending of the branches in these animals is in ourselves effected, apparently in part, through the medium of the sphenopalatine and otic ganglions.

It is remarkable that the supra-maxillary supplies the chief if not all the branches to the temporal and masseter muscles. The upper portion of the infra-maxillary, though passing through the same foramen with the rest of that division, corresponds with branches of the supra-maxillary division in other animals.

The EIGHTH nerve or VAGUS emerges from a hole in the side of the skull behind the suspensorium, the auditory cartilage being between it and the seventh nerve. It immediately breaks into branches. Of these some pass to and supply the branchiæ and some pass to the pharynx. One of the branchial nerves (that to the 5th branchia) runs along the branchial arch to near the middle, passes between the pericardium and the coracoid, penetrates the ventral muscle and runs backwards, beneath the skin, near the ventral mesial line. A *coraco-hyoid* nerve runs downwards, behind the branchiæ, nearly parallel to the preceding, and enters and is distributed in the deep stratum of the ventral muscle between the coracoid and the hyoid. The *Pneumo-gastric* passes backwards to the lungs and along the œsophagus. The *Lateral* nerve is the largest division of the vagus. It sends a branch upwards, behind the suspensorium to the deep part of the dorsal muscle. It then runs directly backwards upon the dorsal surface of the peculiar bone (the large first rib) and the other ribs, and the lateral septum, continuing its course immediately beneath, or in the deepest part of the substance of, the dorsal muscle.

DESCRIPTION OF FIGURES. Pl. XII.

Fig. 23. The part of the animal in the neighbourhood of the ventral fins. The skin and the fascia have been removed to shew the dorsal and ventral muscles with the lateral septum between them. The fibres of the ventral muscle, midway between the lateral septum and the mesial line, are oblique from before downwards and backwards. Those of the subjacent stratum (exposed at *A* by dividing the superficial stratum along the interval between two of the transverse septa and reflecting it forwards and backwards) are, in the same region, oblique from before backwards and upwards. *B*, the edge of the fascia seen to split at the base of the dorsal fin. *C*, the muscles of the dorsal fin thickest in the neighbourhood of the transverse septa, and these overlying the raybones. *D*, the pelvic cartilage with its anterior styliform process lying in a fascial sheath, and its ascending lateral horn. *E*, ventral muscle continued in front and behind upon the fin. *F*, nerves converging upon the dorsal aspect of the fin. *G*, lower part of the intestine ensheathed by the fascia transversalis and terminating in the cloaca which is on the left of the mesial line. (It is usually on one side or the other in this animal, as observed by Peters *Müller's Archiv*, 1845, p. 9. It was on the left side in Owen's specimen.) The muscles on the anal fin resemble those on the dorsal fin.

Fig. 24. Superficial layer of muscles on left side of fore part of body, fin and head. *D*, superficial stratum of dorsal muscle continued into temporal fascia which is continuous with frontal bone (*F*). This fascia has been cut away in front where it was attached to (*N*) the nasal bone, (*Pm.*) the premaxillary bone, (*N. c.*) the nasal cartilages, (*M*) the maxillary bone, (*De.*) the dentary part of the lower jaw, and (*An.*) the angular part of the lower jaw. *T*, temporal muscle. *R. a. o.*, retractor anguli oris. *L. d.*, latissimus dorsi. *P*, pectoral. *Sp. br.*, supra-branchial, or cervicalis superficialis, portion of ventral muscle. Behind the last is the slit-like branchial opening, which is bounded behind by the coracoid with the fibres of the ventral muscle passing to its edge and the coraco-brachial fibres (*C. br.*) running from its edge upon the fin. Between the latissimus dorsi and the pectoral

is the axilla. *Tr.*, trapezius. O^1 and O^2, inferior and superior opercular bones. *L. o.*, levator operculi. *D. m.*, depressor mandibulæ.

Fig. 25. Similar view to the preceding in which the superficial dorsal layer (*D. D.*) and the temporal fascia have been divided longitudinally and reflected upwards and downwards exposing (*T*) the temporal muscle. *M*, the masseter with the branches of the third division of the fifth nerve emerging from between it and the temporal muscle. *R. a. o.*, retractor anguli oris, arising from the suspensorium. *F*, frontal bone. *Pm.*, premaxillary bone. *F. n'.*, fronto-nasal branch of the supra-maxillary division of the fifth nerve; *i. o'.*, infra-orbital branch; *n'*, nasal branch of infra-maxillary; *l*, labial, and *m*, mandibular branches of the infra-maxillary.

Fig. 26. Deep dissection of throat showing disposition of ventral muscle. The superficial stratum (*S. c.*) of lighter colour has been partly divided on the left side and reflected towards the jaw, where, on its under surface *M. h.*, the mylo-hyoid, is seen attached to the jaw and the hyoid, and also forming (*D*) the anterior part of the digastric. *C. b.*, coraco-brachial. *N*, nerve passing to the ventral aspect of the fin. *P*, pectoral. *M. m.*, mucous membrane reflected from hyoid and rudimentary tongue upon superficial stratum of ventral muscle. *S. c.* and *G. h.*, the two layers of the superficial stratum of ventral muscle. *C. p.*, cervicalis profundus, or deep stratum of ventral muscle between (*C*) the coracoid and the hyoid. *R*, thick rib-like bone exposed by dividing part of deep stratum of ventral muscle.

Fig. 27. Right side of skull of Lepidosiren, from which the muscles have been cleared away to show the nerves. The optic is not shewn. *Ophth.*, the ophthalmic of the fifth; *f. n.*, its fronto-nasal branch; *n*, its nasal branch; and *i. o.* its infra-orbital branch. *S. m.*, the supra-maxillary division; *t*, its temporal or muscular branch; *f. n'.*, its fronto-nasal branch; *i. o'.*, its infra-orbital branch. *I. m.*, the infra-maxillary division; *n'*, its nasal branch; *b*, its buccal branch; *m*, its large mandibular branch giving off (*l*) labial branches to outer side of mandible. 7', the branch of the seventh accompanying the mandibular branch of the fifth; 7'', the branch of the seventh to the depressor mandibulæ (*D. m.*), which is continued beneath the mylo-hyoid and curls beneath the jaw reappearing (7''') to supply the lip. *Sq.*, the squamous bone. *S. o.*, the supra-opercular bone. *I. o.*, the infra-opercular bone. *C. h.*, the coraco-hyoid muscle. *D. m.*, the depressor mandibulæ. *L*, the external lateral ligament of the jaw.

THE MUSCLES OF THE SMOOTH DOG-FISH (*Mustelus levis*). By PROFESSOR HUMPHRY (Pl. XIII., Figs. 28 to 33).

FIGURE 28 represents the dorsal aspect of the fore part of the animal, and shews the obliquity of the transverse septa in the upper half (*M. D.*) of the DORSAL muscle, the *mesio-dorsal* muscle as it is sometimes called. In the lower or *latero-dorsal* half (*L. D.*) of the dorsal muscle, the septa form a series of gentle curves with anterior convexity; but in the upper half they are projected forwards into angles, which increase to extreme acuteness as the muscle approaches the head, more so than could be represented in the drawing. The upper lines of the angles are the more oblique and larger, running twice as far backwards as the lower lines or more. There are also a few return septa near the dorsal edge; and the angles formed by these, with the upper lines just mentioned, are prolonged backwards into extremely fine points which are lost in the mesial septum. The pointed extremities of the several angles formed by the union of the septa are thicker than the rest of the septa and show a gradual transition into tendons, some of which are fully developed and run along as distinct delicate tendons for considerable distances without any accompanying muscular fibres; and they are inserted into the median dorsal septum or into the vertebral processes lying in or near the septum. These prolonged tendinous apices of the converged and united septa closely resemble the delicate tendons of the dorsal muscle so remarkably developed in Snakes, and are obviously the representatives of them, rendering it clear that the tendons and the septa are homologous structures.

The muscular fibres situated between the very oblique septa do not retain their antero-posterior direction, but run with some obliquity in a penniform manner.

Turning attention to the VENTRAL muscle, a broad median portion—the medio-ventral portion (*M. V.*), of paler colour than the rest of the lateral muscle, is seen to overlap the more lateral—the latero-ventral—portion, covering it as far as the inverted angles formed by the ventral septa. It has a defined edge and is easily separated from the lateral portion, there being a distinct, though delicate, layer of areolar tissue between the two. This at least is true as regards the muscular fibres, which in both portions are throughout directed antero-posteriorly. The intermuscular septa are, however, continuous and hold the two portions in close relation with each other; and behind, near the ventral fin, the two are blended in the common ventral muscle. In the drawing the middle portion is shown partially reflected; and the subjacent lateral portion is seen in shade.

The median portion, which corresponds with the *brachio-cephalic* portion of the lateral muscle, superficial and deep, of Lepidosiren (p. 258), increases in breadth and distinctness as it advances forwards, and is inserted into nearly the whole length of the shoulder-girdle and into the fin. A little behind the fin it gives off a *superficial stratum*, which, however, is much less segmented from the deep stratum than is the corresponding structure in Lepidosiren. The upper portion of this stratum, representing the *latissimus dorsi* (*L. d.*), is inserted into the scapular part of the girdle, and expands upon the dorsal surface of the root of the fin reaching to its anterior edge. Upon the fin it lies upon, and to some extent blends with, the proper muscle of the fin. In the drawing it is represented as partly reflected from the fin-muscle. The lower portion of the stratum, representing the *pectoralis* (*P*), is inserted into the coracoid part of the girdle, and extends slightly upon the under or ventral surface of the fin, becoming, in some measure, blended with the proper muscle of the fin. An intermediate or *axillary* portion of the stratum forms a furrow, in which the edge of the fin is received. It is inserted into the girdle and into the fin, behind the joint of the fin with the girdle.

I may here remark that the upper or scapular end of the girdle is prolonged into a pointed process, which runs over the lateral septum and projects in between the fibres of the dorsal muscle, where it terminates in a ligament which is lost in one of the transverse septa, not far from the lateral septum. I do not, however, find that any of the fibres of the dorsal muscle are inserted directly into the scapula.

Before reaching the lateral septum and the dorsal muscle the scapula lies upon the upper part of the ventral muscle—the latero-ventral muscle—and its lower edge is connected with one of the transverse septa of this muscle. Moreover, some of the fibres of the muscle pass into its under surface, constituting a *serratus*. These are continuous with fibres of the same muscle farther forward, which pass, from a deep level of the lateral septum, backwards to the under surface of the scapula, and are inserted there, constituting a *levator scapulæ.*

Reverting to the *pectoral* part of the mesio-lateral muscle, which I have described as being inserted into the coracoid, I should add that the more superficial fibres (Fig. 29) are inserted not into the coracoid but into the transverse septum lying between the coracoid and the skin (the coracoid is developed in the deeper part of this septum, which may therefore be called the 'coracoidal' septum). Through the medium of this septum it is continued onwards into a superficial cervical muscle, which may be called '*cervicalis superficialis inferior.*' This last is a thin muscle without septa; and its fibres radiate forwards and outwards. Anteriorly, they pass superficially to the hyoid, acquiring reinforcements of fibres from the mesial line, and are attached to the lower margin of the mandible and also to the hyoid near the angle of the mandible. Posteriorly, they expand, to some extent, upon the fin, as well as are continuous with the pectoral. Laterally, they pass beneath the branchial chamber, are connected slightly with the branchial cartilages, and extend into the gill-covers between the branchial openings. Antero-laterally, between the foremost gill-opening and the jaw, they pass over the fore part of the branchial chamber. Here, as well as between the several branchial openings, they are continued upon the dorsum of the animal as far as the lateral septum, forming what may be called the '*cervicalis superficialis superior.*'

This superior muscle is quite as strongly marked as that on the under surface of the throat and branchial chamber. It may be described as arising on the dorsum of the animal and extending downwards to meet the inferior muscle. Taking this view of it, we find it to arise from the projecting upper and back part of the skull, from the anterior edge of the scapular part of the shoulder-girdle near the fin and, slightly, from the dorsal surface of the fin, where it represents the *trapezius* and meets the *latissimus dorsi*, also from the lateral septum between the shoulder-girdle and the skull. In the last situation the fibres are traceable down, beneath the septum, to the lateral parts of the vertebræ and to the fibres of the deep portion of the ventral muscle passing forwards to the skull. The fibres descend forwards and outwards, over the branchial chamber and the gill covers, and are continuous with the ascending fibres of the *cervicalis superficialis inferior*. They pass over and are slightly connected with the branchial cartilages in the same manner as the fibres of the last-named muscle are related to these cartilages beneath.

The points of difference between the *superficial brachio-cephalic* stratum in this animal and in Lepidosiren (p. 258) are slight, and are caused partly by the difference in the gill openings. The segmentation from the deeper part of the stratum behind the girdle is less distinct in the Dog-fish; and the stratum in front of the girdle does not, in this animal, expand over the dorsal muscle as it does in Lepidosiren. There is further not that distinctly segmented deeper layer of the superficial stratum in or near the mesial line which I have called 'genio-hyoid' in Lepidosiren (p. 261). The *cervicalis superficialis inferior* I suppose to represent, as in Lepidosiren, the inferior part of the *subcutaneus colli*, the *sterno-cleido-mastoideus*, the *mylo-hyoideus*, the anterior belly of the *digastricus* and the *genio-hyoideus*; while the *cervicalis superficialis superior* represents the superior part of the *subcutaneus colli*, the *depressor mandibulæ*, the *levator arcuum*, the *trapezius* with the cervico-humerals and rhomboids.

Beneath the *cervicalis superficialis sup.*, which has been partly cut away in Fig. 28, is seen a strong muscle (*Levator scapulæ*) arising from the lateral septum and from the sides of the vertebræ beneath it. The fibres pass backwards and downwards to be inserted into the under surface of the scapula where they meet the fibres of the lateral muscle, which I have called *serratus*, coming forwards to the same cartilage.

The division and reflection of the *cervicalis superf. inf.* from the middle line, as represented, on the right side in Fig. 29, brings into view the continuation of the deeper layer of the ventral muscle, which may be called *cervicalis profundus* (*C. p.*), from the fore part of the coracoid to the hyoid and the glossal cartilage. It constitutes a thick well-defined muscle, like its homologue in Lepidosiren, and presents transverse septa corresponding in number and position with the branchial cartilages. At its origin this muscle, like the *cerv. superf.*, is connected with the coracoidal septum as well as with the coracoid; and it extends with the septum for some little distance upon the ventral aspect of the fin. The proper muscle of the fin also derives origin from the septum as well as from the coracoid. The septum therefore brings into relation and gives origin to the *cervicalis sup. inf.* and the *cervicalis prof.* in front, and to the *pectoral*, *ventral*, and *fin muscle* behind, linking them all together and to the coracoid[1].

The fin-muscle upon each surface is, in consequence of the different direction of its fibres, like the muscle upon the median fins (see pp. 257, 280), in great measure segmented from the extensions of the lateral muscle which spread upon the fin.

We have traced the superficial stratum of the ventral muscle (*cervicalis superficialis*), over the shoulder-girdle and over the superficial branchial cartilages, and the deep stratum (*cervicalis profundus*) forwards from the coracoid to the hyoid. The deepest stratum of the ventral muscle passes from the deep surface of the girdle upon the deep branchial cartilages[2]. Superiorly, beside the bodies of the vertebræ, it is continued from one cartilage to another, and from the uppermost cartilage to the base of the skull, forming a continuous series of alternating cartilages and muscles, like the ribs and the intercostals. Furthermore some of the fibres are reflected from the hindmost branchial cartilage upon the œsophagus, contributing to the muscular coat of that tube and forming a *diaphragm* between the branchial and pericardial chambers. Some of the fibres also pass from the œsophagus to the vertebral column.

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[1] The course of the nerves to the fin accords with the disposition of the muscles, as compared with those of Lepidosiren and of higher animals. They all pass behind the girdle, except one which penetrates the edge of the girdle immediately behind the point of articulation of the fin. They traverse the ventral muscle in a line behind this point, having above them the part of the ventral muscle attached to the scapula which I have designated *serratus*, and having beneath them the part of the ventral muscle attached to the coracoid, and forming a deeper stratum than the pectoral, which represents the *costo-coracoid*.

[2] The deep branchial cartilages, five in number, commence above, that is beneath the vertebral bodies, by flattened, slightly curved ends, in close contact with the mucous membrane of the pharynx. At the level of the sides of the bodies of the vertebræ they suddenly thicken and turn downwards, running round, in contact with the pharynx, to the median line, where they coalesce with those of the opposite side. The superficial branchial cartilages are nearly subcutaneous, separated from the skin by the fibres of the superficial cervical muscles only. At their upper or vertebral ends they are connected by fibrous tissue with the deep cartilages; and their lower ends expand and underlie the deep cartilages which are also expanded.

The muscular coat of the œsophagus is further augmented by a small muscle on either side which extends, from the base of the skull and the foremost vertebræ, upon the upper flat ends of the branchial cartilages and upon the œsophagus.

A second or post-cardiac *diaphragm* is formed by a layer of the fascia transversalis reflected from the hinder edge of the girdle upon the œsophagus. It is not accompanied by any muscular fibres.

VENTRAL FIN (Fig. 30). The dorsal muscle (*Gl.*) of the ventral fin is broad and square-shaped, and in part continuous with the superficial strata of the ventral muscle, whereas, behind, it overlies the ventral muscle and is easily dissected from it. It thus affords a good example of transition from continuity with the lateral muscle to superposition with regard to it. As it descends upon the fin it blends with the proper muscles of the fin and extends also upon the clasper. It represents the *gluteus maximus*, together, probably, with the *sartorius* and *tensor vaginæ femoris* (see also Ceratodus, p. 283). I do not trace any of the fibres of the caudal part of the ventral muscle into the back of this fin-muscle or into the back of the fin or the clasper. The caudal muscle is, however, largely inserted into the pelvis behind, as is the ventral abdominal muscle in front. Near the mesial line the pelvis quite interrupts the ventral muscle, cutting off the caudal from the abdominal part, and lying in contact with the visceral cavity. More laterally, however, the pelvic cartilage is imbedded in the ventral muscle, the fibres of which are continued, on both its superficial and deep surfaces, from the caudal to the abdominal region.

The following description of three transverse sections of the animal, together with the drawings (Figs. 31, 32 and 33) and the accounts of them at p. 278, shew the relations of the lateral muscles to the septa, to the vertebræ and their processes and to the median fins.

A transverse section of the animal through the anterior dorsal fin (Fig. 31) shows the lateral septum (*L. s.*) passing from the laterally projecting margins of the body of the vertebra, quite on a level with its lower surface which is flattened or slightly concave. It first takes a sweep downwards, then ascends to the part where it appears on the surface.

Beneath it, the ventral muscle is extended over the abdominal cavity and presents one thick oblique septum (*C*) indicating the commencement of the medio-ventral part of the muscle (*M. V.*). Above the lateral septum septa radiate from the middle of the neural arch about the position of the articulating processes. There is no neural spine, or a very short one. The median neural septum is continued, from the summit of the neural arch, to the cartilage of the fin, and there splits into the septa (*A. A.*) which separate the fin-muscles, on the two sides, from the lateral muscles. These last-mentioned septa resemble the other septa of the lateral muscle, though they are rather thicker; and their relations indicate the fin-muscle to be a segment of the lateral muscle. The cartilaginous fin-ray extends far beyond the fin-muscle into the fins; and its extremity is embraced by the horny subcutaneous fibres of the fin, which pass on either side of it.

In a section (Fig. 32) through the posterior dorsal fin and the anal fin the lateral septum is seen passing from the side of the hæmal canal, at a point below the body of the vertebra, about corresponding with the point, above, from which a septum passes from the side of the neural canal, a point, that is, answering to the articulating processes. The neural spine is somewhat pronounced, as is also the hæmal. The cartilaginous rays extend into the hæmal as well as into the dorsal fin.

In a section (Fig. 33) through the caudal fin the relations of the lateral septum to the hæmal canal correspond with those in the section just described. The neural and hæmal spines, especially the latter, are much more prolonged, extending quite to the bases of the respective fins; and the horny filaments of the fins embrace their ends, much as, in the dorsal fin, they embrace the free ends of the cartilaginous rays. These rays are here absent, and there are no fin-muscles.

Thus the neural and hæmal spines are reciprocal with regard to the cartilaginous rays. When these are developed and penetrate between the lateral muscles the spines are short or abortive; and, on the contrary, when the rays are abortive, the spines run on into the fins.

DESCRIPTION OF FIGURES. (Pl. XIII.)

Fig. 28. Dissection of the upper surface of the fore part of the Dog-fish, to show the angular prolongations of the septa of (*M. D.*) the medio-dorsal part of the lateral muscle. *L. D.*, the latero-dorsal part of the same. *L. V.*, the latero-ventral, and *M. V.*, the medio-ventral. *Lat. d.*, latissimus dorsi, which has been partly reflected from the fin-muscle. *P*, pectoral. *C. s. s.*, cervicalis superficialis superior, its supra-branchial portion. *D. F.*, the dorsal fin.

Fig. 29. Dissection of the under surface of the fore part of the Dog-fish. *M. V.*, the medio-ventral portion of the lateral muscle. *P*, its superficial, or pectoralis, layer advancing to the fin and to (*C. S.*) the coracoidal septum. *C. s. i.*, the cervicalis superficialis inferior, which, on the left side of the animal, is in situ, but, on the right side, has been reflected to shew (*C. pr.*) the cervicalis profundus, and the superficial branchial cartilages. The hinder fibres of the cervicalis pr. are seen passing upon the fin and connected with the fin-muscle. *G. H.*, the glosso-hyal. *C. H.*, cerato-hyal. *B*, branchiostegal rays.

Fig. 30. Side view of a portion of the hinder part of the Dog-fish to show the relation of the dorsal muscle (*Gl.*) of the ventral fin (*V. F.*) to (*L*) the lateral muscle. *P. D. F.*, the posterior dorsal fin. *Cl. Cl.*, the claspers.

Fig. 31. Section through the anterior dorsal fin and the body wall. *L. S.*, lateral septum. *A*, septum between the dorso-lateral muscle and the fin-muscle, passing to the root of one of the cartilaginous fin-rays, and continued on, as a median septum, to the dorsal spinous process. *A′*, similar septum to the fin-ray above. *B*, septum from neural arch separating *D. L.*, the dorso-lateral muscle from *M. D.*, the medio-dorsal muscle. *C*, septum between (*V. L.*) the ventro-lateral and (*M. V.*) the medio-ventral muscle. The parts of the vertebra which are ossified are distinguished from the cartilaginous parts by not being dotted.

Fig. 32. Section through the post-dorsal (*P. d. F.*) and the anal (*A. F.*) fins. *V*, the ventral muscle behind the part where it is divided into medio-ventral and ventro-lateral. *D*, septum between the ventral muscle and the anal fin and fin-muscle. *A*, septum between the dorsal muscle and the dorsal fin and fin-muscle.

Fig. 33. Section through the caudal fin showing the prolongation of the neural and hæmal spines into the fin. *L. S.*, lateral septum. *N. S.* is the divided end of an overhanging neural spine; and *H. S.* is the divided end of an underlying hæmal spine.

THE MUSCLES OF CERATODUS. By Professor Humphry. (Plate XIV. Figs. 34 to 38[1]).

Lateral and Mesial Fin-Muscles.

The lateral muscle presents the usual general piscine characters. There is, however, none of the superficial, soft, coloured stratum often found over and near the lateral septum[2]. The ventral intermuscular septa simply slant from the lateral septum backwards and downwards to the ventral line. Traced inwards they pass obliquely forwards to the ribs, or to the transversalis fascia in the trunk, and in the tail to the hæmal spines and the median septum. Near the pectoral girdle the direction of their slant is reversed. The dorsal intermuscular strata, at first, slant backwards and upwards from the lateral septum; then they curve forwards to the line at which the dorsal fin-muscles impinge upon the lateral muscle. Here the direction is again suddenly changed; and they slant backwards and upwards, through the fin-muscle, with a greater obliquity than they present near the lateral septum. The septa in the muscle extending upon the side of the dorsal median fin are distinctly continuations of the septa of the lateral muscle, though their direction is somewhat different. The same disposition is observed throughout the tail; except that as they are traced backwards the curves of the septa disappear; and in the hinder part of the tail the septa extend as straight lines, obliquely backwards and upwards, through the dorsal part of the lateral muscle and onwards, with merely an increase of obliquity, through the fin-muscle. In like manner the septa of the ventral part of the lateral muscle, behind the anus, merely acquire an increased slant backwards when they traverse the muscle upon the sides of the median fin.

Near the lateral septum the fibres of the lateral muscle, ventral and dorsal, take an antero-posterior direction, a direction that is parallel with the direction of the septum and of the axis of the animal. As they become more distant from the septum they acquire a slant; the fibres of the ventral muscle inclining a little downwards and backwards and those of the dorsal muscle a little upwards and backwards. Near the ventral mesial line the direction of the fibres is again antero-posterior; but near the dorsal mesial line the fibres still retain a slight obliquity. Dissected from without inwards the fibres of the deeper parts of the ventral muscle are found to preserve much the same direction as do those near the exterior; that is, no difference is traceable which would indicate an incipient division into external and internal oblique, such as was observed in Lepidosiren (p. 256) and more markedly in Cryptobranch (p. 11). We notice that as they approach the interior they become intermingled with an increasing number of threads of fibrous tissue which take the place of the muscular fibres. In some places a tolerably distinct stratum of these, passing from rib to rib or septum to septum, lies upon the transversalis fascia. There are no muscular fibres beneath the level of the ribs to represent a transversalis muscle. This decreasing proportion of muscular fibres towards the interior of the abdominal wall is interesting as an indication that the development of its muscular tissue become less active as we approach the interior (see obs. on the Tadpole, p. 301).

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[1] For the opportunity of dissecting this animal I am indebted to the kindness of Prof. Flower, of the Royal College of Surgeons. It was dissected for me by Mr Anningson. The anatomy of Ceratodus, with the exception of the muscles, has been fully described by Dr Günther, in an admirable paper contained in the *Phil. Trans. of the Roy. Soc.* for 1871.

[2] This was also absent in Lepidosiren and Ceratodus. See obs. p. 294.

The intermuscular septal planes being continued into the muscle of the median fin, it follows that the muscular planes are likewise so continued, and that the fin-muscle is an extension of the lateral muscle. There are, however, some distinguishing points. First, the direction of the fibres is different. The fibres of the fin-muscle are nearly parallel with the fin-rays, that is, have a much more vertical course than those of the dorsal muscle; and the change in direction takes place suddenly, the fibres of the fin-muscle impinging upon those of the dorsal muscle at an angle which approaches to a right angle. Hence the one set are segmented from the other; and a layer of the superficial fascia, as described in Lepidosiren, and shewn in Fig. 31 of Dog-fish, passes between them, covers the edge of the lateral muscle, and meets its fellow in the mesial line, or comes into relation with the fin bones and the vertebral spines; while the other, or outer, layer is continued upon the surface of the fin-muscle and the fin. The fin-muscle and fin are continued in a channel between the two fascial layers just mentioned, and are transversely segmented by septa crossing the channel and continuous with the transverse septa of the lateral muscle. The fin-ray bones are ossifications in the meeting-points of the septa of the two sides in the median line; just as the spinous processes and ribs are ossifications in the median or other parts of the transverse septa of the lateral muscle. The fin-muscle is accordingly divided into bundles, which correspond in number with the interspinous and fin-ray bones; and each bundle is inclosed in a fascial sheath which separates it from the adjacent bundles as well as from the lateral muscle. Each bundle also is composed of fibres running parallel with the fin-ray and springing from the surrounding sheath, chiefly from the basal part of the sheath which rests upon the lateral muscle, but partly from the septa which separate them from the fibres of contiguous bundles.

The superficial or EXTERNAL FASCIA is unusually thick. It is connected by areolar tissue with the derma on the one side-face, and with the septa of the lateral muscle on the other; these connecting it, as in Lepidosiren and Cryptobranch, with the fibres of the lateral muscle and with the deep, or internal, or *transversalis fascia.* It is also continuous with the *transversalis fascia* along the ventral edge of the animal; and, in the abdominal region, the blended fasciæ of the two sides are united in the median line, forming a median septum. Behind the pelvis the blended superficial and deep fasciæ on the one side are separated from those of the other by the bowel passing between them to the anus; and a sheath formed by them is continued upon it (see also Fig. 23, *G*).

MUSCLES OF PELVIC AND PECTORAL FINS.

The cartilaginous pelvis, with its smooth anterior, or prepubic, styliform cartilage and its lateral cornua, resembles that of Lepidosiren (p. 257 and Fig. 23); but the cornua are shorter, and each is forked (Fig. 34 *C*), terminating in two blunt prongs, into the hinder of which two intermuscular septa converging are inserted. Behind, the pelvis terminates in a semilunar edge, with a condyloid projection on either side for the articulation of the paddle-like fin[1].

The styliform process is enclosed in a sheath of the blended fasciæ, as in Lepidosiren. The cornua lie in the lateral muscle, the fibres of which are attached to their anterior and posterior surfaces. The under surface of the pelvis is covered, on each side, by a thick muscular mass, the fibres of which are parallel with those of the lateral muscle, though they are separated from them by a cleft. This mass is divided into two nearly equal portions—a median or 'plantar' and a lateral or 'dorsal;' and the line of division between them corresponds with, and is a continuation of, the line of the inferior edge of the fin. The dorsal or lateral portion (*Gl.* Fig. 34) passes upon the dorsal or outer surface of the fin; and the plantar portion passes upon the ventral or inner surface of the fin nearly to its extremity[2]. Each, in its course upon the pelvis and upon the fin, is marked by transverse inscriptions, like those of the caudal lateral muscle. These inscriptions are transverse upon the proximal thick part of the fin; but, on the more distal part of the fin, they become oblique, slanting from the middle or axial line of the fin, backwards and outwards towards the margin of the fin. They correspond with and overlie the lines of division of the axial cartilage of the fin into pieces; and they extend over the rays which pass, in a penniform manner, from those lines. They do not extend between the pieces of the axial cartilage so far as the margin of the fin, but only about half-way from the axis to the margin. In the intervals between them the muscular fibres are directed longitudinally, parallel, that is, with the axis of the fin. In the more marginal parts of the fin the muscular fibres slant off obliquely, from the middle longitudinal set, which form the proper muscle of the fin, towards the margin; and the two sets are to some extent segmented from each other, in the same

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[1] Günther, *l. c.* p. 535 and figures. In Cryptobranch the prepubic cartilage is not continuous with the pelvic cartilage, as in Ceratodus and Lepidosiren, but jointed to it by fibrous tissue. It is also less cylindrical and small, and bifurcates anteriorly into two flat unsymmetrical horns.

[2] I use the words 'plantar' and 'dorsal' in reference to those portions of the fin-muscle, to indicate their correspondence with the respective groups of muscles passing to the hind limb in higher animals.

manner as the muscles of the median fin of the body and tail are segmented from the adjacent parts of the lateral muscle, but less distinctly. Towards the extremity of the fin the distinction between the two sets becomes less marked; and, at last, the middle set of fibres are continued without interruption to the edge of the fin (Fig. 34). This similarity in the construction of this almost uniquely bipinnate fin or paddle and in the arrangement of its muscles, to the construction of the tail and to the arrangement of the muscles of the tail, is highly interesting. It is strongly confirmatory of the view I have formed, from the dissection of this animal and Lepidosiren, that the muscles of the mesial fin are derivations from the lateral muscles, presenting varying degrees of continuity with, or segmentation and separation from, them.

The muscle on the dorsal surface of the fin is not derived entirely from the girdle. It receives a direct accession from the lateral muscle in the form of fibres which converge, from several of the segments of the lateral muscle, upon the fin, and which blend in one of the septa of the fin muscle (Fig. 34, *G'l.*). Of these fibres the foremost, running parallel or nearly so with those of the lateral muscle, are continued uninterruptedly into them. The hinder fibres, crossing that muscle more at an angle, are segmented from it, lie upon its surface, and are without difficulty dissected from it, affording, like the corresponding muscle in the Dog-fish (p. 276, Fig. 30), another illustration of gradual segmentation in consequence of increasing difference of direction.

The accession to the dorsal fin-muscle represents not uncertainly the sheet of the ventral muscle extending upon the dorsal aspect of the corresponding limb in higher animals, which may be partially or wholly interrupted by the ilium growing through it, and which becomes more or less segmented into *sartorius*, *tensor vaginæ femoris*, and *gluteus*. The part of the muscle derived from the pelvis represents the deeper *glutei*, &c.

In like manner the muscle on the ventral aspect of the fin is not derived altogether from the plantar and internal or mesial portion of the sub-pelvic mass just described. It is joined by bundles of fibres from the deep surface of the hinder or ischiatic part of the pelvis; and, moreover, some of the fibres from the lower edge of the ventral muscle passing forwards from the tail (*Pl.* Fig. 36) are reflected into it.

This accession to the plantar fin-muscle from the caudal part of the ventral muscle may be regarded as representing the caudo-appendicular series of Urodelans which are variously segmented into caudo-pedal, caudo-crural and caudo-femoral.

The disposition of muscles upon the pectoral fin, which is also a bipinnate paddle, resembles closely that of the muscles upon the ventral fin, except that they are formed altogether by fibres passing from the girdle, there being no accessions from the lateral muscle, no correspondents, that is, with the *latissimus dorsi* and *pectoralis.* The fibres that arise from the scapular part of the girdle—the part above the joint with the fin—form a 'scapulo-brachial' muscle, which passes upon the dorsal aspect of the fin; and the fibres that arise from the coracoid part of the girdle—the part beneath the joint with the fin—form a 'coraco-brachial' muscle which passes upon the ventral aspect of the fin.

BRACHIO-CEPHALIC MUSCLES.

Traced forwards the ventral muscle does not give off, as in Lepidosiren, a superficial brachio-cephalic muscular stratum; though the superficial fascia, which represents it, is continued forwards over the girdle to the jaw. A representative of the cervical or cephalic portion (*cervicalis superficialis*) of this muscular stratum is, however, found in front of the pectoral limb-girdle in the form of a muscular layer composed of fibres or bundles passing transversely, or in a slightly curvilinear manner, over the gill-cover (Fig. 34, *C. s.*). Traced upwards these fibres do not reach the lateral septum, but are attached to the girdle (the scapular part of it) above the fin, to the supra-scapula, and the backwardly projecting cartilaginous occipital angle of the cranium. Anteriorly, they encounter and are attached to the opercular and sub-opercular bones, the hinder ends of which project into and interrupt the layer, and to the lower jaw. Inferiorly, they extend beneath the throat, and are lost in the extension of the superficial fascia. By this means only they acquire connection with the rest of the ventral muscle. They take chiefly a transverse direction, and bear close resemblance to the corresponding *cervicalis superficialis* of Lepidosiren and Dog-fish. The reflection of it, as in Fig. 37, shews it to be inserted strongly into the cerato-hyoid cartilage (*C. Hd.*), also into the jaw near its angle, as well as into the opercular bones, and into the body of the jaw (*M*) between the angle and the symphysis. There are not any fibres running forwards from the hyoid to the symphysis and corresponding to those which in Lepidosiren (p. 261) I have supposed to represent the anterior belly of the digastric.

This muscle is mentioned, and partly described by Günther, p. 525. Lying beneath the outer or posterior half of the suboperculum, closely united with and projecting beyond it, so coming into relation with the fibres of the muscle just described, is a remarkable plate of cartilage, represented at *S. o. c.* Fig. 37, which is not mentioned by Günther. It is quite separate from all the cartilages of the skull, and is connected only with the suboperculum, though lying near the hinder edge of the cerato-hyoid cartilage. There is not any similar cartilage under the operculum; for the small cartilage described as pre-operculum by Günther is quite separate from the operculum.

Beneath the *cervicalis superficialis,* near the middle line, is the muscle which I have described in Lepidosiren (p. 259, and Dog-fish, p. 273), as the deep layer of the *cervicalis superficialis.* In this animal it is more separate from the remainder of the *cervicalis sup.* than it is in Lepidosiren; and it constitutes a distinct *genio-coracoid* (*G. c.* Fig. 37). It is flat, riband-like, and attached behind to half-an-inch of the anterior edge of the coracoid cartilage, and of the epicoracoid-bone (p. 294), near the middle line. It extends, forwards, to the under-surface of the hinder edge of the mandible near the symphysis. It passes beneath the hyoid, and is not connected with it; still its fore-part may, and probably does, represent the genio-hyoid of other animals or the hyo-mental (p. 325).

The DEEP LAYER OF THE BRACHIO-CEPHALIC EXTENSION is disposed much as in Lepidosiren. It first, in its lateral part, encounters the peculiar bone, or first rib, which appears to be formed in the lateral part of one of its septa. From the anterior and outer surface of this bone is given off a thick muscle (*serratus*), which is a continuation of this stratum, to the under-surface of the scapula. A little more anteriorly and near the middle line the brachio-cephalic is inserted into the coracoid cartilage and the epicoracoid septum which quite interrupt it. In front of the coracoid it is continued as a thick muscle, but without septa, to the hyoid forming a *coraco-hyoid*, the representative apparently of the sterno-hyoid. The middle part is inserted into the base of the cone-shaped glosso-hyal by a flat tendon which passes beneath the basi-hyal. The fibres of its lateral part, which are situated in rather a deeper level, are inserted into the basi-hyal.

DESCRIPTION OF THE FIGURES OF CERATODUS (Pl. XIV.).

Fig. 34. A side-view of the animal, shewing *D*, the dorsal, and *V*, the ventral muscle, and the lateral septum between them.

P, the styliform prepubic cartilage turned out of its median sheath, and inclined upon the left side of the ventral muscle. *C*, cornua of pelvic cartilage. *Gl.*, dorsal-fin muscle passing from the pelvis, upon the dorsal surface of the ventral fin. *Gl.'*, accession to dorsal-fin muscle from lateral muscle. *A*, the anus. *S. F.*, the superficial fascia reflected from the outer-surface of the ventral muscle. It joins (*T*) the transversalis fascia coming from the inner-surface of the ventral muscle. The two united are continued upon the bowel. *O.*, opercular bone. *S. O.*, sub-opercular bone. *C. s. s.*, cervicalis superficialis superior muscle (its supra-branchial portion) passing over gill-cover. *C. Br.*, coraco-brachial mass passing upon the ventral aspect of the fin. *S. Br.*, scapulo-brachial muscle passing upon the dorsal aspect of the fin.

Fig. 35. A piece of the lateral muscle with one of the myotomes dissected out to shew the sclerotome, or intermuscular septum, *I. M.*, passing inwards and forwards above and below the lateral septum to *F*, the fin-ray bone, and *R*, the rib, in which it terminates, as well as in the side of the body of the vertebra between them. *R'*, a rib in front. The transversalis fascia is seen between the two ribs with an outer coating of tendinous fibres which slant, from above downwards (ventrally) and forwards, in a direction that is different from those of the muscular fibres above them, and corresponding with that usual in internal intercostals or depressores costarum. The cut ends of the fibres of the ventral muscular bundles are seen in front of the gap; whereas the dorsal fibres have been cleared away in the corresponding situation, and the under-surface of the septum next adjacent has been there exposed.

Fig. 36. The pelvis and fin with part of the lateral muscle. *P*, the prepubic cartilage. *Gl.*, the dorsal muscle from pelvis to fin, and *Gl.'*, the accession to it from the ventral muscle. The latter has been divided and reflected to shew *Pl.*, the plantar muscle from the pelvis to the fin, and *Pl.'*, the accession to it from the caudal part of the ventral muscle.

Fig. 37. Dissection of the deeper muscles in the under-surface of the throat. *V*, the ventral, or brachio-cephalic part of the ventral muscle. *S. F.*, superficial fascia passing over *C*, the coracoid to *S*, the symphysis of the mandible. *C. s. s.*, cervicalis superficialis superior inserted into, *S. o.*, the sub-operculum. *S. o. c.*, the sub-opercular cartilage. *C. h.*, the cerato-hyal, and *M*, the mandible. *C. H.*, the coraco-hyoid inserted into *G. h.*, the glosso-hyal, and *B. h.*, the basi-hyal. *G. c.*, the genio-coracoid of the right side. *G.c'.*, the genio-coracoid of the left side turned back in its middle and hinder part. *C. Br.*, coraco-brachial.

Fig. 38 shews the connection of the fore part of the ventral or brachio-cephalic muscular mass, and its septa with the coracoid. *C. C.*, the coracoid cartilage. *C'*, the epicoracoid bone. The muscular fibres have been left near the middle line, but dissected away more laterally to shew the septa which here slant, from the surface, backwards and inwards. The foremost septum is continued into the coracoid. The next has the peculiar rib-bone, *R*, projecting into it. It is continued into that bone. *C. Br.*, the coraco-brachial muscle extending from the girdle, beneath the joint with the fin, upon the ventral surface of the fin. *S. Br.*, scapulo-brachial muscle extending from the girdle, above the joint with the fin, upon the dorsal surface of the fin.

NOTES ON THE MUSCLES OF THE GLASS-SNAKE.

Pseudopus Pallasii[1]. By PROFESSOR HUMPHRY.

THE hind-limb is a mere slight scaly projection from the margin of the ventral articular plate, where the latter is being rounded off to form the anterior wall of the cloaca. The pelvic girdle is attached, above, to the transverse process of one vertebra[2].

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[1] This animal was dissected for me by Mr Anningson.

[2] The ilium extends a little above the transverse process; and the inner side of the ilium is applied upon the extremity of the transverse process (the second behind the last rib); a ball and socket is formed, the round end of the transverse process being received in a shallow socket in the ilium; and there is a synovial cavity with a thick surrounding capsule. The arrangement permits the lower ends of the two pelvic bones to swing backwards and forwards upon an axis traversing the transverse processes of the two sides. This movement is

Beneath, it is free in the abdominal wall, i.e., not connected with that of the opposite side. The small osseous limb marks, by its point of connection with the pelvis, the division between the iliac and the pubischiatic, or ischiatic, parts of the pelvis.

The *rectus abdominis* is a more distinct and continuous sheath than in the Snakes I have seen. It is joined by the successive bundles of the *obliquus externus abdominis* passing from the ribs into its upper or abdominal surface. Traced back it is quite interrupted by, or inserted into, the pubischiatic bone; and the hindmost division, or bundle of the external oblique muscle is inserted with it, and above it, i.e. deeper than it, into the same bone.

Examined more carefully the *rectus abdominis* (*longissimus abdominis* of Fürbringer[1]) is found to be composed, *first*, of bundles directed, forwards and outwards into it, from the extremity of the ribs and the costal cartilages, the hindmost of the bundles being attached to the mesial part of the pelvic bone (they resemble detached portions of external intercostal muscles); *secondly*, of bundles passing backwards and downwards, into it from the ribs nearer the vertebræ. These two sets of bundles lie in the same oblique lines; and they are confluent in the substance of the rectus. That muscle may therefore be said to be formed, either of bundles passing from the ribs near the vertebræ into it, travelling for a distance in it, and then leaving it to be attached to the free ends of the ribs and the costal cartilages; or, it may be described as being formed of fibres which take the opposite direction, that is, arising from the free ends of the ribs, joining it, and then leaving it to be inserted into the ribs near the vertebræ[2].

These bundles run chiefly into the deeper surface of the

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restricted by a fibrous band connecting the ilium with the transverse process next in front of it, the transverse process that is next behind the last rib. In an articulated skeleton in the Cambridge Museum the ilium is connected directly with the transverse processes of two vertebræ.

The limb consists of one longer bone next the pelvis, carrying a smaller bone, a mere nodule, upon its end. These bones should scarcely be named tibia and femur. They are as much representatives of the other limb-bones as of these two.

[1] *Die Knocken und Muskeln der Extremitäten der schlangenähnlichen Sauriern*, von Max Fürbringer. Leipzig, 1870.

[2] This is the case also in Snakes; though in them the bundles are finer and run more into the scutes, and form a less distinct antero-posterior muscle.

lateral part of the rectus. Its more mesial part is formed, wholly or nearly, of antero-posteriorly directed fibres[1].

Behind the pubischiatic bone is a continuation of the series of external oblique muscular fibres, backwards, to the cloaca and into the caudal muscle on the side of the cloaca, so constituting an *ischio-cloacalis* and an *ischio-coccygeus*. These, it will be understood, are separated from the *rectus* and the *obliquus* by the pelvic bone.

Radiating forwards and inwards to the middle line from the median extremity of the pubischiatic bone is a *pyramidalis*. It is quite distinct, though thin; and it is broad. It lies along the inner side of the rectus; and the *pyramidales* of the two sides occupy the space on the ventral surface of the abdomen which is left uncovered by the *recti* diverging as they pass backwards to the pubischiatic bones[2]. This muscle is not described by Fürbringer.

The *gracilis* passes from the pubischiatic bone, where it is partially continuous with the *rectus abdominis*, into the inner or plantar side of the limb, and is attached to both the bones of the limb. Beneath the *gracilis* some deeper fibres, passing from the pubischiatic bone to the upper limb-bone, represent the *adductors*.

The deeper stratum of the abdominal muscle, the stratum, that is, beneath the level of the *obliquus externus* and the *rectus*, which extends more laterally than they, and in which the ribs are situated, and which therefore corresponds with the *obliquus internus*, if traced backwards is found to pass, in great measure, superficial to the ilium, into the ventral caudal muscle. Some fibres are, however, inserted into the ilium; and a tolerably distinct part of it passes, from the hindmost rib, to the ilium, constituting a *quadratus lumborum* and representing serially the intercostals.

If this internal oblique stratum is traced forwards, from the tail, a larger number of its fibres are found to be inserted into the hinder edge of the ilium, constituting an *ilio-caudal;* and one distinct bundle of fibres is found to pass beneath the ilium and to terminate in a tendon which runs on into the abdominal muscles; so that though the ilium lies deep it does not lie quite so deep as it does in Snakes, the ventral muscle being partially inserted into it and even partially travelling beneath it.

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[1] These might be described as a *third* set. They are, however, probably continuous indirectly with the others.

[2] See similar disposition in Pteropus, *Journ. Anat.*

When the layer of the abdominal muscle travelling over the ilium is divided, a muscle is seen passing from the outer surface of the ilium upon the upper limb-bone. It is a representative of the deep *glutei.*

We do not discover any part sufficiently distinct to deserve the name *rectus femoris;* though such a muscle is described by Fürbringer.

The *transversalis* stratum of the abdominal muscles is represented by a sheet of muscular fibres passing from the sides of the bodies of the vertebræ, forwards and laterally, upon the under surface of the ribs, so forming *depressores costarum.* Some of these are traceable beneath three or four of the ribs. They decrease in thickness as they extend laterally; and they are scarcely traceable beneath the mesial parts of the ribs. The nerves lie between them, on the one side, and the ribs and the more superficial strata, on the other side. There is no *subvertebral rectus.* The *rectus capitis* is strong, arising from the anterior five or six vertebræ, also from the side of the hæmal spines of the three foremost vertebræ, and is inserted into the lateral part of the occipital. It encroaches upon the region usually occupied by the *longus colli.* These two muscles are however, as before shewn (p. 17), segments from one subvertebral mass.

BRACHIO-CEPHALIC MUSCLES.

NEAR the girdle the components of the *rectus abdominis* muscle radiate and separate into planes. The most superficial passes over the sternum and girdle, beneath the throat, over the lower jaw and side of the neck, and is lost in the tissue upon the back of the neck and head, thus constituting the *subcutaneus colli.*

Next beneath this, and crossing the direction of its fibres, is a tolerably defined muscle, the *depressor mandibulæ* (*cervici submaxillaris* of Fürbringer), arising from the fibrous tissue over the cervical spines and running, forwards and downwards, to the side of the angle of the lower jaw.

A little in front of the clavicle these two muscles are blended in a transverse inscription about two lines in length. This is supposed to be a representative of the acromion by Rudinger. It extends also through the subjacent stratum.

The next plane, partially interrupted by attachment to the sternum and clavicle, is continued forwards. Its more mesial portion runs under the clavicle, beneath the throat, to the hyoid and lower jaw as superficial *sterno-hyoid* (Fürbringer) and *genio-hyoid, hyo-mental,* and *mylo-hyoid.* The more lateral part—*sterno-cleido-mastoid*—a flat band slightly connected on its deeper-surface with the clavicle[1], runs to the back of the suspensorium (squamous or mastoid). It is superficially interrupted or divided into two—an anterior and a posterior part—by the inscription above mentioned.

More laterally still, that is, above the sterno-mastoid and rather on a deeper level than it, arising from the anterior edge of the upper, and scapular part of the clavicle, and on the same level with fibres of the sterno-hyoid and continuous with it, is a muscle which is called by Fürbringer a part of the sterno-mastoid, but which appears to me more properly to be called *trapezius.* It passes forwards to be inserted into the back of the suspensorium, immediately behind the sterno-mastoid, with which it is more closely connected near the skull than it is near the girdle.

These constitute the SUPERFICIAL BRACHIO-CEPHALIC STRATUM; those next described constituting the DEEP BRACHIO-CEPHALIC STRATUM.

The third, or deepest plane of the ventral muscle passing to the girdle, consists, *first,* of a broad muscle passing from the first rib, in nearly its whole length, to the hinder edge of the deeper surface of the scapula; *secondly,* of a broad bundle from the mesial part of the second rib to the hinder edge of the scapula; *thirdly*, of a narrower longer bundle from the mesial part of the third rib to the hinder edge of the coracoid near the sternum and to the sternum. It passes on also over the coracoid to the clavicle. *Fourthly*, a long thin band is attached to the coracoid. It runs nearly straight backwards over about a dozen ribs and, finally, blends with the intercostals. Of these, the first two appear to belong to the 'serratus' group, and the last two to the 'costo-coracoid' group. The absence of a limb precludes the opportunity of ascertaining whether the nerves to the limb pass, as they usually do, between the two groups[1].

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[1] It is rather remarkable that the clavicle in its upper or scapular part is in, that is interrupts, this plane. Whereas in its lower or sternal part it lies beneath it, and interrupts the deepest plane of the brachio-cephalic mass. The superficial sterno-hyoid muscle passes quite superficially with regard to the clavicle, with the exception of a few of its lateral fibres which are continuous with the trapezius, and which are attached to the clavicle; whereas the deep sterno-hyoid is interrupted by the clavicle.

The *levator scapulæ* is a continuation of this plane onwards from the anterior edge of the upper part of the scapula, beneath the *trapezius*, to the transverse process of the first cervical vertebræ.

A *sterno-hyoideus profundus* (Fürbringer) passes from the anterior edge of the sternum to the hyoid. It is not distinctly continuous with any of the preceding. It is interrupted by the clavicle; and the hinder part of it is called *episterno-clavicularis* by Fürbringer. A few fibres passing from the sternum to the coracoid constitute a *sterno-coracoideus.*

Sterno-costalis (*triangularis sterni*) radiates, from a tendinous attachment to the hinder surface of the sternum, upon the deeper surface of several of the foremost ribs: it is in the stratum of the transversalis. There is no trace of diaphragm.

Scaleni are continuations forwards of the muscles between and upon the ribs to the cervical transverse processes. One slip reaches the lateral part of the occipital.

Latissimus dorsi (*trapezius* of Fürbringer) is small and thin, arising from the spines of five or six vertebræ behind the girdle. It is in the same plane with the *trapezius* but does not reach it. Its fibres converge; and the flat muscle formed by them passes over the dorsal surface of the scapula, lying upon the scapular cartilage but deriving no fibres from it, and is inserted into the hinder edge of the clavicle.

Near the scapula it is joined by a bundle from the *rectus abdominis*, which is a serial continuation of the bundles passing, from the lateral part of the *rectus*, to the ribs near the vertebræ.

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[1] Nos. 2 and 3 are described by Rüdinger as *Pectoralis minor*, by Fürbringer as *sterno-costo scapularis.*

ON THE DISPOSITION OF MUSCLES IN VERTEBRATE ANIMALS. By Professor Humphry[1].

The locomotory system of a vertebrate animal consists, fundamentally, of a successional series of alternating transverse skeletal and muscular planes which extend nearly through the outer wall of the animal. I say *nearly* through, for in and around the axial line, and in the immediate mesial plane, this alternation does not exist. The skeletal elements here form a continuous structure composed, in the axial line, during the early fœtal state, and persistently in the Lancelet, of a simple cartilaginous notochordal streak, but usually, at a later period, of cartilaginous or osseous pieces articulated directly together or connected by ligamentous material. This vertebral column extends throughout the whole length of the animal; and cartilaginous or osseous processes run out from it, or in connection with it, more or less transversely, and serve as levers to aid the muscles besides fulfilling other purposes. It is obvious, however, that these processes must, in proportion to their length and unyielding character, limit the range of movement of the axial pieces upon one another and so lessen the flexibility of the animal. Accordingly, in the circumferential regions, especially in the directions in which movement is most required, the skeletal parts are not osseous or even cartilaginous, but are membranous and composed of fibrous plates extending from the axial osseous or cartilaginous structures to the skin. This may be the case throughout the whole of the muscular stratum as in the Lancelet, where the membranous septa extend from the skin down to the notochordal sheath and blend with it. The muscular planes occupy the intervals between the osseous processes and between the fibrous plates, the latter being continuous with the osseous axial pieces and their processes.

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[1] The anatomical points mentioned in this paper, unless otherwise specified, are all from notes, published in the *Journ. of Anat.*, or in manuscript, of dissections made by Mr Anningson or myself. I have not been able to investigate the now copious literature of the subject so much as I could have wished.

This arrangement is found most distinct in the simplest parts of the lower vertebrates, as throughout the Lancelet and in the caudal region of Fishes and Urodelans. The structure of that region, with its longitudinal divisions caused by the dorsal, neural and lateral septa, and its transverse divisions caused by the transverse septa, has been described in the Cryptobranch (p. 3)[1].

The transverse skeletal planes, membranous, cartilaginous and osseous, are sometimes called 'sclerotomes' and the transverse muscular planes between them 'myotomes.' Very rarely, however, are the planes truly transverse. They commonly slant with more or less obliquity, backwards or forwards, from the axial line towards the circumference. An additional and more perplexing element of confusion is imported by the membranous or fibrous portions of the sclerotomes—the intermuscular septa as they are called—not preserving a uniform direction, but slanting first one way then another, first backwards and then forwards, or vice versâ, as they are traced from the upper or dorsal edge of the animal. Thus they acquire a more or less waving or zigzag line; and their superficial margins come to deviate considerably from the lines of their deeper margins and the lines of the osseous vertebral processes to which they are attached. Moreover the several curves or angles so formed may be produced to a great length. Especially is this the case near the mesial line, above—in the 'mesio-dorsal' part of the lateral muscle. Here the angles of the septa are often prolonged to a considerable distance; and in some Fishes (Bream and Dog-fish) they are, near the surface, thickened into tendons with the muscular fibres on the two sides of each passing obliquely between it and the adjacent septa, which has the effect of allowing the traction of a large number of muscular fibres to be brought to bear upon a given point or points (p. 271, Fig. 28). Where this occurs the intermuscular septa cease to run directly into the skin or to retain their close connection with it; for the cutaneous terminal filaments become converted into loose areolar tissue. Hence the tendinous septa as well as the intervening muscular planes, near the dorsal median line, in the Fishes above mentioned and in others, are allowed to glide with greater freedom beneath the skin than are the more lateral and ventral muscles, which are bound to the skin by the intermuscular septa running from the axial osseous structures into it.

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[1] I should observe that the angular spaces left between the longitudinal divisions are not always, as in Cryptobranch, occupied by fat. In the Fish the dorsal and ventral furrows are often partly occupied by the dorsal and anal fins (see pp. 256, 277); and the lateral furrows are commonly occupied by muscular fibres which bear the transverse septa, but which are more closely connected with the skin, and peel off with it more easily than the rest of the lateral muscle. These fibres are more vascular than ordinary muscular fibres; and in a piece which I examined from a Dace they contained more oil than the other muscles. Stannius (*Handbuch der Zootomie*, II. 112) says that they, in addition, present microscopically the appearance of tissue in process of conversion into muscle. I did not find that to be the case. With the exception of the excess of oil, they presented the usual microscopical characters of striped muscle.

Stannius (II. 93) uses the terms 'epaxonisch' and 'hypaxonisch' to indicate the muscles above and below the axial vertebral line. Huxley (*The Anatomy of Vertebrate Animals*) uses the terms 'episkeletal' and 'hyposkeletal' to indicate the muscles situated respectively above and below the endoskeleton, and developed from above and beneath the protovertebræ. Strictly speaking, however, all the muscles are *interskeletal;* forasmuch as the intermuscular septa extend, from the transversalis fascia to the skin, through the entire thickness of the muscular layer which appears to be primarily and essentially one, and which is, for aught we know, all developed from the same embryonic protovertebral stratum; and the skeletal tissues undergo chondrification and ossification in certain parts only and in certain planes. The parts in which these changes take place are chiefly in and near the axial line. The plane in which chondrification and ossification occur is almost exclusively the middle one; and ossification without chondrification—i. e. from membrane—is most frequent in the superficial muscular plane; though it may take place much deeper, as in the instances of the parasphenoid, or sub-basal, bone and the vomer. I am not here speaking of the epidermal, or superficial dermal, tissues which may also be changed into horny matter, cartilage or bone. The ossifications in this epidermal layer are as distinct from those in the outer, or subcutaneous, muscular plane as these are from the chondrifications and ossifications in the middle muscular plane, or more so; and I do not think this distinction has been quite sufficiently kept in mind. It must not be forgotten that the 'cartilaginous,' the 'membranous,' and the 'epidermal' ossifications may be blended, and that the two former are particularly liable to be so. Indeed, those that begin in cartilage are usually enlarged by the addition of membrane bone. Histologically, there is perhaps no essential difference between the two.

It is, I think, far better to reserve the prefix 'epi' to designate the bones—membrane bones—which are formed, usually, though as above mentioned not always, in the superficial muscular or subcutaneous strata, and thereby distinguish them from the subjacent cartilage bones with which they are often closely related. Thus the 'episternals' and the 'epicostals' are indicated to be bones found in the tissue overlying the sternum and the costæ; and the 'epicoracoids' are bones or bony plates formed over, or upon, perhaps blended with, the coracoids.

A further change consists in the isolation of the prolonged and tendinous superficial parts of the septa from one another, and, to a greater or less extent, from their muscular contingents, as well as from the deeper and the superficial structures; so that they run alone to their destinations and admit of traction without hindrance. This is effected by the conversion of the surrounding connecting structures into loose tissue, as just mentioned in the case of their isolation from the skin. Such a condition we find developed to perfection in the numerous delicate muscles and tendons which lie along the sides of the dorsal spinous processes of Snakes.

Thus, by comparatively simple stages of transition, the elongated longitudinal dorsal muscles are brought into relation with, or reduced from, the simple primary transverse muscular strata; and it is to be remarked that while this change takes place, usually in some degree and in many instances to the extent I have mentioned, in the upper or 'mesio-dorsal' part of the lateral muscle, the transverse disposition is commonly maintained through the visceral region, at any rate in the opposite and lowest, or 'mesio-ventral' part of the same muscle. Witness the transverse direction of the septa when they are persistent in the *rectus abdominis* and in its extensions into the neck and the tail.

So much for the variations in the fibrous plates or septa of the skeletal structure. Then, with regard to the muscles between them. These, in the simple condition, occupy the intervals between the septa and are composed throughout of fibres passing, antero-posteriorly, from one septum to another. Through the medium of the septa the fibres of one compartment are connected with those of the adjacent compartment, and also with the subcutaneous fascia and the skin, as well as with the osseous structures of the skeleton and the internal or transversalis fascia. I have already mentioned that where the septa are very oblique the muscular fibres between them usually take an oblique direction also.

Sometimes the fibres at one part of the thickness of the lateral muscle take an oblique direction different from those at another depth. This alone is sufficient to cause a cleavage into planes; and the cleavage usually extends through the septa as well as between the muscular fibres, so causing the separation of one or more superimposed muscular sheets which are thus rendered capable of moving upon one another[1].

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[1] The cleavage of a muscle into two planes, in consequence of a difference in the direction of its superficial and deep fibres, is well illustrated in the *pectoralis*

The Cryptobranch (p. 10) and the Lepidosiren (p. 256) offer examples of the cleavage being confined to the muscular elements without involving the septa. When the cleavage involves the septa these may remain (p. 258). Commonly they disappear, more or less completely, throughout the thickness of the muscular substance. A continuity, or ankylosis of the muscular fibres of the several compartments is thus established; and all trace of the primary, transversely segmented, myotomic arrangement is obliterated[1].

Even without an alteration in the direction of the muscular fibres a cleavage into superficial and deeper planes may take place; and it may take place completely or partially. Thus a superficial stratum of muscular fibres, having the same or a different direction from those beneath them, may be quite severed from the deeper strata. It may retain here and there connection with the skin only, so forming, as is the case with portions of the pannicle, a purely 'cutaneous' or as commonly designated 'subcutaneous' muscle; or it may retain, at one or more places, a connection with the deeper strata of the muscle or, through remnants of the transverse septa, with the osseous skeleton. Thus it may be, as numerous varieties of the pannicle shew, a 'musculo-cutaneous' or 'osseo-cutaneous' muscle[2]. Lastly, a given layer may be severed from the deeper strata in a part only of its length, and may retain a connection, through the septa, which as already mentioned are equivalent to tendons, at both ends, either with the subjacent muscle or with the subjacent skeleton; witness some of the dorsal muscles, the muscles passing to the girdles, and many others. That is to say, a superficial or cutaneous stratum may be segmented more or less completely from the rest of the muscular system; and various strata of

major of Cyclothurus (*Journ. Anat.* IV. 25), and still better in that of the Wild Cat, in which there are no less than four layers.

[1] This is exemplified even in the Myxinoid fish Bdellostoma; and the contrast between the absence of inscriptions, or '*ligamenta intermuscularia*,' in the oblique muscles, and their presence in the straight muscles, is well shewn in Tab. I. accompanying Müller's well-known paper, *Abhandl. Berlin. Akad.* 1834.

[2] In Pteropus (*Journ. Anat.* III. 299), the cutaneous muscles are connected with the skull, the sternum, the coracoid, the pelvis, and the femur, thus presenting unusually numerous and good examples of 'osseo-cutaneous' muscles. They are also remarkably well developed and have several osseous connections in the Hedgehog.

the remaining deeper portion may be more or less completely segmented from each other.

It is a very common thing for the muscular fibres to miss, that is, to pass over or under, one or more septa, as in the case of the erector spinæ and the subcostals. In these instances, and others of the like kind, the muscular fibres are continued through, or are ankylosed through, the septal tissue which has disappeared as such, owing to the embryonic tissue of the intermuscular septa undergoing the same histological change as the muscular parts. See p. 301.

A muscular plane, or any part of it, may also be divided longitudinally into portions or sectors by cleavages similar to that by which itself was separated from the strata above or beneath it.

Thus from the simple primary, transversely segmented, lateral muscle, on either side of the animal, the various muscular forms may be elicited. Moreover the differences in the muscular systems of different animals, and in different though serially homologous parts of the same animal, may in great measure be explained by variations in the number of the strata or of the sectors, or by variations in the depths at which the several strata have been detached, or in the points at which the several sectors have been separated. Hence, although general correspondence may be indicated, precise homology must not be too closely pressed.

The processes which I have mentioned may be recapitulated as follows: 1, varieties in the inclination and direction of the septa; 2, prolongation of the angles of the septa caused by increased inclination and flexure; 3, separation of the thus prolonged septa with their appended muscular fibres, individually or in groups, into independent muscles; 4, variation in the direction of the muscular fibres; 5, cleavage into planes and into sectors reaching to various depths; 6, fusion or ankylosis of the muscular segments by the establishment of continuity through the septa.

In the three highest orders of vertebrates, if we exclude the vertebral processes, the ribs, the hyoid and the limb girdles, which are ossifications in the deeper parts of the septa, and the tendons of the dorsal muscles, which are modifications of the septa, the intermuscular septa are represented only, or chiefly, by the inscriptions in the *rectus abdominis, biventer cervicis, digastric* and *omo-hyoid,* by occasional inscriptions in the *sterno-hyoid* and *sterno-thyroid,* by the clavicle or the inscription which, in carnivora and some others, is substituted for it between the *trapezius* and the *deltoid,* and by Poupart's ligament.

The fibres in these animals retain their simple antero-posterior direction between the successive skeletal septa in the instances of the *interspinales* and *intertransversales* and in the *recti-abdominis,* though in the last some of the septa have been obliterated. In the *semispinales* the fibres run obliquely between the successive skeletal structures and also in the *intercostales.* In these last, the direction of the obliquity varying at two parts of the depth between the successive ribs, two strata are formed resembling the two strata of external and internal oblique between the successive ribs and septa in the abdomen of Cryptobranch (p. 10). These and other variations will, however, be mentioned as we proceed.

Reverting to the plan of the construction of the locomotory system of a vertebrate animal, we have found it to consist of a series of transverse, alternating, skeletal and muscular planes or discs, traversed by an antero-posterior axial line, the whole being enclosed in an external fascial sheet which is also part of the skeletal system and which lies beneath the skin. A transverse section shews that each disc is in two lateral halves applied, as it were, upon the axial line which is formed by the notochord or the vertebral bodies. Each half constitutes one side of the animal. Owing to the obliquity with which the planes or discs slant from the axial line, a transverse section passes through both the muscular and the skeletal planes and shews their relative disposition. Such a section indicates the locomotory system of an animal to consist on each side of a fascial, or skeletal, tube enclosing a muscular cylinder, which last is traversed by transverse or oblique, fascial or skeletal planes. The approximated sides of the skeletal tubes are flattened against each other, above and below the axial line; and becoming fused here in great part of their extent they form mesial septa passing, dorsally and ventrally, from the axial line.

This is well illustrated by the section of the tail of a Tadpole (Fig. 41)[1], in which the fascial walls on either side, ascending and descending from the notochord and enclosing the neural and hæmal canals, meet and so form the dorsal and hæmal septa. These run peripherally into the upper and lower membranous edges of the tail, where they are joined by the fascial layers from the exterior of the lateral muscle. Thus each membranous edge of the tail is composed, essentially, of four sheets —the two mesial sheets which are blended together and form the septum, neural or hæmal, and the two external, or lateral, sheets which are derived from the superficial covering, or fascia, of the lateral muscle. It is interesting to observe that at the extremity of the tail (Fig. 39), as well as along its upper and lower edges, the membranous sheets alone exist, the muscular fibres being absent; so that the mesial and external membranous plates are in contact. A little in front of the extremity of the tail the muscular fibres begin to appear, in patches, separating the external from the mesial plates. The patches are in broken rows; still they succeed one another in serial order. Gradually, as they are traced forwards, the rows are filled up and the membranous interspaces between them become reduced to the narrow intermuscular septa; while the muscles, increasing in thickness, acquire the semicircular or ovoid form which is seen on either side of the median line in a transverse section (Fig. 41). It is thus perceived that the membranous, or intermuscular, element is the first formed, that the muscular fibres are produced, or added in it, that the intermuscular septa and fascial sheets are remnants of it, and that these give way, in greater or less degree, before the force of muscular development.

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[1] The specimens of Pseudis Tadpole, from which the drawings were made, were kindly sent me by Mr Mivart.

Description of Figures of the Pseudis Tadpole (Pl. XV.).

Fig. 39.—Side view of the animal, shewing the lateral muscle of the tail. This at the hinder part is in interrupted fragments, which are serially arranged in rows with wide septa between the rows. Further forwards the muscular fibres are more developed, filling in the rows and diminishing the intervals between them. A pin (*C*) is placed in the cloacal opening; another, above *B*, is in the branchial opening. Above, and in front of the branchial opening, is the eye. The small hind limb is seen on the hinder wall of the visceral cavity, or rather in the furrow between it and the tail, above *L*.

Fig. 40.—The visceral cavity laid open in a specimen more advanced where the cavity is more elongated. The transversely marked ventral portions of the lateral muscle are seen extending, from the tail, along the sides of the bodies of the vertebræ, and projecting into the visceral cavity, with an interval between them leading down to the hæmal passage which has ceased to be a covered canal, and is merely a channel. The wall of the visceral cavity has been turned back; and the commencing development of its muscle is shewn, in isolated tracts, by fine muscular fibres arranged in rows between broad, white (septal) lines.

Fig. 41.—A transverse section at about the middle of the tail. The large central circle is the notochord, with a small neural canal above and a small hæmal canal below.—*D. F.*, the dorsal, or neural, membranous fringe.—*V. F.*, the ventral, or hæmal, membranous fringe. The neural septum extends from the notochord up the middle of the one, and the hæmal septum down the middle of the other. The sides of both are formed by extensions of the membrane covering the lateral muscle. The base of each, between the mesial septum and the external membrane, is occupied by soft succulent tissue which is separated from the lateral muscle by an offset from the external enveloping membrane.

Fig. 42.—A section through the animal, made at the back part of the visceral cavity, and seen from in front. *D. F.*, the dorsal fringe with the neural septum descending, through its middle, to the neural canal and the notochord. Beneath the latter is the hæmal passage at the bottom of a deep channel between the lateral muscles of the two sides, or, rather, between the plates of the hæmal septum, which have not coalesced, and which separate the hæmal channel from the lateral muscles. Beneath this channel is, *C*, the cloacal tube. *A* is the wide posterior cul-de-sac of the abdominal wall, with the muscular fibres beginning to be developed in rows between the paler lines, which indicate the future septa.

Fig. 43.—A section farther forwards. *A*, the abdominal, or visceral, wall ascends, is reflected, higher on the sides of the lateral muscle, reaching to the dorsal part of that muscle. The hæmal channel is wider and forms part of the visceral cavity.

Usually, in other animals, ossification takes place, to a greater or less extent, around the notochord, giving rise to the bodies of the vertebræ, and extends into the ascending and descending mesial laminæ, forming the neural and hæmal arches and spines. In Fishes (Figs. 31, 32 and 33) it also often extends into these laminæ, where they stretch, like the membranous fringe of the Tadpole's tail, beyond the confines of the lateral muscle. Thus are formed the fin-ray bones, which, like the septa, are double, actually or potentially; and muscular fibres are formed upon them. These have the same relations to the membranous laminæ, and the same segmentation, as the fibres of the lateral muscles, and are, indeed, extensions of them, though they take a different direction, and are, consequently, segmented from them (p. 257).

In front of the tail, in the visceral region, the mesial hæmal laminæ are kept apart; and the visceral cavity is formed between them. In other words, they are spread out over it, and form the *fascia transversalis.* This separation of them may, in the hindmost region of the visceral area, be confined to the marginal part of the hæmal septum: thus, in Fig. 39 of the Tadpole, the cloacal tube and aperture are seen to lie at the junction of the membranous caudal fringe with the abdomen; and they are the result of a want of adhesion of the mesial laminæ which form that fringe. In the Fish the cloacal fissure, or separation, of the mesial laminæ, usually extends deeper into the region of the hæmal spines, which are, accordingly, bifurcate and arch transversely over this part of the visceral cavity instead of, as in the tail, occupying a median position, and each pair being fused into a single process. In front of the cloacal region, and through the rest of the visceral cavity, with occasional exceptions near the head, the separation of the mesial laminæ extends down to the vertebræ, splitting the hæmal arches of the two sides quite asunder, and laying the hæmal canal open to the visceral cavity. Towards the fore part of the visceral cavity the mesial laminæ and the hæmal arches are pressed so far upwards upon the vertebral bodies that the arches come to occupy the place of ribs.

The wall of the visceral cavity is thus formed by the separated and expanded hæmal plates, and not merely by those parts of the plates upon which, in the tail, the lateral muscle is formed, but by those parts also which form the membranous hæmal fringe in the Tadpole's tail, and in which the subcaudal or anal fin is formed in the Fish. In the Tadpole it is chiefly this latter, membranous, fringe-like part which becomes expanded; for the lateral muscle (the ventral portion of it) is continued, without much alteration, from the tail, forwards, through the abdomen[1], as represented in Figs. 40, 42 and 43. These figures further shew the manner in which the membranous part is spread out and is reflected upon the sides of the lateral muscles, so as to give greater space for the contents of the visceral cavity; and they shew the mode in which the development of the abdominal muscles is commencing in the thickness of the wall by broken serial rows of muscular fibres with intervening septal lines, upon which the muscular transformation gradually encroaches, in the same manner as the development of the lateral muscle is progressing at the end of the tail (Fig. 39). Further, in Fig. 40, an extension from the sides of the lateral muscle is seen to be proceeding into the hinder part of the abdominal wall. In the Fish, the part of the hæmal plate in which, in the tail, the lateral muscle is developed becomes, in the abdomen, more expanded than it does in the Tadpole, and forms, at any rate, the ventro-lateral (*V. L.*, Fig. 31) portion of the body-wall. It is not improbable that the part in which, in the tail, the anal sub-caudal fin is developed is continued forwards into the abdomen as the mesio-ventral (*M. V.*, Fig. 31) portion of the body-wall. Of this, however, I cannot be sure, the two parts (*V. L.* and *M. L.*) being, as we might expect from their development in one continuous hæmal plate, blended into one 'lateral' muscle[1]. There can, however, be little doubt that, as pointed out by me, in a paper "on the Homology of the Mesial and Lateral Fins of Fishes," in this *Journal*, Vol. V., the ventral and pectoral fins and their muscles are formed from the same serial elements as the sub-caudal or anal fins and their muscles.

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[1] It is reduced and becomes the *quadratus lumborum* in the Frog.

I will now consider, briefly,

THE DORSAL MUSCLES OF THE TRUNK,

that is, the muscles situated above the lateral septum. These, though numerous, in accordance with the number of the vertebræ that require to be moved upon one another, do not present much variety or much interest in different animals. In the Fish the dorsal mass from which they are derived indicates a division into an upper or 'mesio-dorsal' and a lower or 'latero-dorsal' part. This division corresponds on the whole with that into the *spinalis* and *longissimus dorsi* and the *sacro-lumbalis* parts in higher animals. Such incipient longitudinal segmentation is less marked in Cryptobranch, Perennibranch, and Lepidosiren, than it usually is in Fishes. It is seen again in the Salamanders.

The dorsal muscles may be arranged, as follows, in two divisions:

First, those in which the fibres retain the primary antero-posterior direction and pass between corresponding parts of contiguous or distant vertebræ. Those connected with contiguous

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[1] Supposing this view to be correct, the sternal ribs and the sternum would be serial representatives, not of the hæmal processes but, of the osseous elements of the subcaudal fin—the fin ray-bones—of the Fish.

vertebræ are commonly designated in accordance with the parts of the vertebræ between which they pass. Thus they are called '*Interspinales*', '*Intertransversales*', and '*Interobliqui*' or '*Interaccessorii*'. The foremost of them is the *Rectus capitis posticus minor*. They are developed in proportion to the mobility of the parts between which they pass, that is, they are most developed in the neck and loins, and least in the back. In the back the *intertransversales* and *interspinales* are sometimes merely ligamentous. In the more superficial members of this series the fibres sometimes leap over one or more segments to a distant point. This is caused by the superficial fusion of two or more septa, owing to the non-development of muscular fibres between them, or by the superficial obliteration of one or more septa from the extension of muscle-development through them, producing, in the one case, an elongation of septum or tendon, and, in the other, an elongation of muscle. In this manner are formed the *spinalis dorsi* and *spinalis colli* and the several parts of the *erectores spinæ*. The last, it may be observed, often overlap, to some extent, and are connected with the ventral parts of the skeleton, viz., the iliac bones and the ribs, parts, that is, which lie beneath the lateral line.

The *second* division includes the muscles in which the fibres have an oblique direction and pass between non-corresponding parts of contiguous or distant vertebræ, for instance, from transverse process to spine, or from spinous process to transverse process. The obliquity is therefore in two directions, giving rise to two sets, the fibres of which cross one another. In the one set the fibres pass from spinous processes *out*wards and forwards to the transverse processes; and in the other set, which is on the whole in a deeper plane, the fibres pass from the transverse processes *in*wards and forwards to the spinous processes. The more superficial, spino-transverse or *out*wardly directed, set comprises the *obliquus capitis inferior*, and the *splenius capitis* and *colli*. The deeper, transverso-spinous or *in*wardly directed, set comprises the *obliquus capitis superior*, the *complexus* with the *biventer*, the *semispinalis colli* and *dorsi*, the *multifidus* and *rotatores spinæ*.

The dissections of Cryptobranch (Fig. 20) and of Lepidosiren (Fig. 25) show conclusively that the *temporal* muscle is a prolongation of the dorsal muscle forwards from the neck, beside the cranial neural arches, over the suspensorium, to the lower jaw, and that the temporal fascia is the continuation of the fascial aponeurosis of the dorsal muscle. They render it probable that the *masseter* and *external pterygoid*, and also the ocular muscles, are an extension of the same series. According to this view the temporal ridge which, in most vertebrates, shuts off the masticatory muscles from the rest of the dorsal system, may be regarded as an ossification of, or an ossification extending into, a transverse intermuscular septum, an ossification, that is, in the superficial stratum of the dorsal muscle passing upon the head.

The *ligamentum nuchæ* and the interspinous ligaments, as well as the ligamentous bands tying the skin to the several spinous processes, are modifications of the longitudinal median septum which I have already (pp. 254, 300) described.

The modifications of the dorsal muscle in the tail do not require any special description. It may be sufficient to remark that in cases where the pelvis is absent or rudimentary, as in the Porpoise, the portion of it called *erector spinæ* is continued uninterruptedly from the lumbar to the caudal region.

THE VENTRAL MUSCLE

is subject to much greater modifications in the different regions of its course than is the dorsal. In the hinder part of the tail it much resembles the dorsal muscle of the same part; but, anteriorly, the symmetry between the muscles above and below the lateral line is destroyed by the expansion of the ventral muscle over the visceral cavity, by the formation of the limb-girdles in its substance, and by its relation to the limbs. Travelling forwards it first comes into relation with the openings of the alimentary, urinary, and genital organs, and detaches muscles to them. It then encounters the pelvis and hind limb, which, more or less, interrupt and make demands upon it. Next it is expanded, and the direction of its fibres is modified, by the visceral cavity. Then the shoulder-girdle and fore-limb, the branchial and hyoidean apparatus, the larynx and pharynx, the lower jaw and the face necessitate modifications to meet their several requirements, which vary in different animals, and which lead to almost infinite diversities in the disposition of the several parts of the muscle.

The ventral muscle, and this is important, not unfrequently overlaps the dorsal muscle. Such is described by Müller to be the case in Bdellostoma[1]; and superficial fibres or strata of it are often prolonged into the tissue over the dorsal muscle, so reaching the dorsal spines, or are continued as distinct muscles to this region (see pp. 13, 260, and Fig. 24). This occurs especially towards the fore part of the trunk, and is exemplified particularly in Snakes (Fig. 44); and this extension contributes to the formation of the superficial muscles of the neck, throat and face, as well as to those of the limb-girdle and limb.

While the superficial strata of the ventral muscle thus overlap the dorsal muscle, and reach to the dorsal median line, the deeper strata, as represented by the intercostals and the ribs, are commonly, to some extent, overlapped by it; so that the lateral margin of the dorsal muscle is received between the layers of the ventral muscle.

In the simplest condition, as in the ordinary teleostean fish, the ventral muscle does not undergo much change in its different parts. The two fascial hæmal plates, as has just been shewn, which line the apposed sides of the ventral muscle, in some parts of the tail coalesce beneath the hæmal spines, and form a median osseo-membranous septum, extending from the hæmal spines to the skin. At other parts they are separated by the caudal or anal fins. At the foremost part of the tail they are also separated; and the commencement of the visceral space exists between them, but walled off from the hæmal space by the hæmal arches still bridging over the latter. Further forward the separation is greater, the osseous hæmal arches disappear, the hæmal and visceral cavities are laid into one, or are divided only by membrane. The ventral muscles of the two sides are pushed asunder; and the separated membranous hæmal plates which line them are named the *fascia transversalis*. Ossifications in the inner parts of the transverse septa which pass from the fascia transversalis, through the lateral muscle, to the external fascia and the skin, form the ribs.

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[1] *Abhandl. der Akad.* Berlin, 1834, s. 245. It may be observed also that in Bdellostoma (*l.c.* p. 246) the superficial fibres of the ventral muscle, in the interval between the head and the hinder opening of the gills, cross the median line and are continued from either side upon the surface of the ventral muscle of the opposite side, where they are lost in the superficial fascia. This, however, is quite exceptional.

The latter thus correspond serially, or nearly so, to the hæmal spines, split and pressed asunder, and to the sides of the hæmal arches. If an interval is left between the ribs and the transversalis fascia, in which muscle is developed, it constitutes the *transversalis* muscle, or it may constitute the *levatores*, or, more commonly, the *depressores costarum*, according to its position[1]; and when this muscular sheet extends beneath the bodies of the vertebræ it constitutes the *subvertebral rectus* (p. 11).

The mesial edges of the ventral muscles, inferiorly, are separated and covered by *fascia transversalis* continued round each into the *external fascia*. Behind, there is an interval between the contiguous edges of the ventral muscle, thus covered by fascia, which permits the passage of the alimentary tube to the anus. A layer of the fascia (Fig. 23, *G*) accompanies the tube and binds it to the skin; and some muscular fibres may be developed around it forming a sphincter.

In front of the anus the pelvic bones lie between the *fascia transversalis* and the ventral muscle, or in the substance of the deeper layers of the ventral muscle, in the same plane, that is, as the ribs. The fins project between the mesial edges of the ventral muscle; but marginal portions, or (Bream) a larger amount of the deep stratum, of that muscle are attached to the pelvic bones, constituting a '*retractor*' or '*protractor*'; and more superficial portions constitute what are sometimes called '*carinales*' muscles. In some Fishes (Ceratodus) portions of the ventral muscle extend upon both surfaces of the fin. The pectoral fin projects at a more lateral point; and the ventral muscle is attached more largely to its girdle which, like the pelvic bones, occupies the same relative position, with reference to the thickness of the abdominal wall, as the ribs. From it the ventral muscle is continued forwards to the hyoid and the head.

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[1] In the Bream, Dace, and some other Fish, there is a sheet of muscular fibres passing from the vertebræ forwards and downwards internal to the ribs, that is, taking a direction corresponding to the internal intercostals and subcostals of mammals, and to the internal intercostals, *depressores costarum* and *transversalis* of Cryptobranch. In Ceratodus (p. 280) I have described tendinous fibres taking the same direction. Some are attached to the ribs nearest to their point of origin, others to more distant ribs. The nerves are external to this sheet. Towards the fore part of the body of the Dace fibrous bands take the place of these subcostals.

The median third or half of the ventral muscle is not unfrequently distinguished from the remainder in Fishes by the mere transverse direction of its septa. In some, as the Dogfish (Fig. 28), it is segmented from the remainder, in great part of its extent, and overlaps it. In Mammals also it is separate, as *rectus*, and is enclosed in a sheath formed by prolongations of the lateral portions of the ventral muscle, or their tendons, to the mesial line. Its continuity with the lateral parts of the ventral muscle has been shewn in Cryptobranch (p. 11), and in Lepidosiren (p. 256). In Cryptobranch, however, it must be observed that while the more superficial or *oblique* strata of the ventral muscle are continued into the *rectus*, the deepest or *transversalis* stratum, separating itself from the others, passes upon the deeper surface of the *rectus* to the middle line; and in Mammals the *rectus* is ensheathed by tendinous extensions from the deep, or peritoneal, and the superficial, or cutaneous, divisions of the ventral muscle which pass, upon its peritoneal and cutaneous surfaces, to the middle line. Though we are in the habit of thus referring the walls of the sheath of the *rectus* to the expansions of the lateral parts of the *ventral* muscle, we may, with equal right, assume them to be deep and superficial strata of the *median* part of the ventral muscle, that is, derivations from the *rectus* itself. And as, on the one hand, they retain their continuity with the lateral parts of the muscle, so, on the other hand, do they retain their connections with the *rectus*, or middle stratum of the same, through the transverse inscriptions which extend from it into them.

As already intimated the ventral muscle is disposed in three chief planes or strata which are in variable degrees distinguishable in different animals and in different parts of the same animal. Of these, the middle—or internal oblique—plane is that in the septa of which the pieces of the true or cartilage skeleton are for the most part developed: the external—or external oblique—stratum is connected with the external fascia and the skin, and is that in which the pieces of the dermal or membrane skeleton are for the most part developed: and the internal—or transversalis—plane is connected with the internal or transversalis fascia and the viscera, much in the same way as the external plane is connected with the external fascia and the skin. The connection with the viscera, however, is in great part interrupted by the formation of the visceral cavity. Primarily all the planes are continuous or, rather, formed one plane from the skin to the visceral tube. It remains so in the Leech. In the Earthworm the transverse septa still connect the visceral tube and its muscles with the dermal sheet and its muscles. In higher animals the visceral cavity interrupts the septa; and they are restricted to the dermo-muscular layer, except near the oral and anal apertures, and in the situation of the diaphragm or diaphragms, where the inner layer or layers of the dermo-muscular sheet bend in towards and come into contact with the visceral sheet of the animal. In the Fish the dermo-muscular sheet is, for the most part, in one undivided plane, with the septa extending throughout it and connecting the skin with the fascia transversalis. In Batrachians the muscular part is more separate from the skin on the one side, and the fascia transversalis on the other; and the stratification of the muscular part into the three planes above-mentioned is commencing.

We will first take the INNERMOST—the TRANSVERSALIS—STRATUM of the ventral muscle, the stratum that lies internal to or beneath the osseous skeleton, or between the innermost parts of the skeleton, and internal to the chief nervous and vascular trunks. In most Fishes (though not in all, p. 307) it is absent, or partial or rudimentary, being represented by tendinous or fascial structures and scarcely distinguishable from the *fascia transversalis.* It may enter with that fascia into the formation of the *post-cardiac diaphragm;* and it is sometimes (Dog-fish) a main constituent of the *pre-cardiac diaphragm.* In Cryptobranch we have found it very extensively disposed beneath the ribs and the rest of the wall of the abdominal cavity, forming the *depressores costarum* and the *transversalis* muscle. It also lies beneath the vertebral column, from the pelvis to the head, forming the *subvertebral rectus;* and there is no *diaphragm.* In higher animals it seldom is present as a continuous sheet in this last situation; but portions of it remain, forming the *longus colli,* the *rectus capitis anticus,* the *crura* of the *diaphragm* and the *retractor ani.* On the interior of the lateral parts of the abdomen and thorax it is usually present in animals above Fishes, forming the *transversalis* muscle and the *depressores costarum*[1], also the internal *intercostals* and the *triangularis sterni*[2] with the *subcostals.* It is continued, with more or less interruption, within the pelvis and is then gathered in around the bowel as a pelvic diaphragm, or *levator ani*, some of its fibres being reflected into, and some continued into, the muscular coat of the bowel. In some instances—Pseudopus P. (p. 289), Cryptobranch (p. 17) and others—a part of it is continued on into the subcaudal muscles. In Mammals a stratum is inflected from the ribs, or gathered in like the *levator ani*, upon the alimentary tube, forming the lateral portions of the post-cardiac *diaphragm* which, in continuity with a remnant of the subvertebral portion (the *crura*), constitutes a septum shutting off the thoracic from the abdominal regions, but with apertures, like those in the pelvic diaphragm, for the passage of the œsophagus and the vascular and neural trunks. The *psoas magnus* and *parvus* also appear to be derivatives from this stratum[1], as well as some fibres of the *cremaster*.

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[1] These last are strongly developed in Snakes, and are quite segmented from the *transversalis* with an interval between them and it, in which the *levatores costarum* appear.

[2] The *triangularis sterni* and the *transversalis* are sometimes continuous in Man, as remarked by Stannius, Rosenmüller and Meckel.

It will be evident that the direction of the fibres of this stratum varies much in different parts of its extent, being antero-posterior where it lies under the vertebral column, oblique where it lies under or between the ribs, transverse where it forms the abdominal wall, and converging where it is inflected upon the viscera; and in proportion to the diversity in the direction of their fibres the several parts are segmented from each other.

In Cryptobranch it is throughout, or nearly, traversed by septa, and is so held in continuity with the *transversalis fascia*, on the one side, and the rest of the ventral muscle and the components of the osseo-cartilaginous skeleton on the other. In higher animals, however, the septa for the most part disappear in its substance and upon its surfaces. They still abide forming the lines of separation between the digitations of the *transversalis* muscle and the *diaphragm*, as well as between the members of the internal intercostal series, blended in the latter situation with the costal periosteum or perichondrium.

The *internal* or *transversalis fascia* is in contact with the greater part of the extent of the internal surface of the transversalis stratum and is gathered in with it to form the *levator ani* and the post-cardiac diaphragm. Thus it lies upon the anterior and posterior surfaces of both those diaphragms and reaches and is continued upon the alimentary tube[1]. From the anterior surface of the *levator ani* it is reflected upon the rectum and the bladder; and from the posterior surface it is continued to the integuments of the anus and the superficial fascia of the perineum. The part of the internal fascia behind the gathering-in of the *levator ani* forms the true pelvic fascia lining the obturator muscle; and it is stretched beneath the pubes as the triangular ligament. The part of the internal fascia in front of the diaphragm lines the intercostals and the ribs and is gathered in, in front of the first rib, as the precardiac diaphragm, or the deep cervical fascia, between the thoracic and the cervical regions. The internal fascia is also continued upon the inner surface of the cremasteric projection of the transversalis muscle, forming what is called the *fascia propria* of the spermatic cord. Just in front of the pubes, in Man and some other animals, the internal fascia is separated from the *transversalis* muscle which there passes with the internal oblique in front of the *rectus*.

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[1] In the Guinea Pig the *psoas parvus* passes with the *ps. magnus* and the *iliacus* over the pubes to the lesser trochanter of the femur.

The MIDDLE—the INTERNAL OBLIQUE—STRATUM is the most persistently intra-skeletal of the three strata of the ventral muscle; and the intermuscular septa traversing it are, in many places, solidified by conversion into cartilage and bone. Thus, the ribs and sternum, the limb-girdles and the hyoid are developed in it, and chiefly in its inner layers, though they may, and occasionally do, the limb-girdles more particularly, grow through the other strata and come into contact with the *fascia transversalis*, on the one side, and with the skin, or the *fascia superficialis*, on the other.

In the abdomen this stratum forms the *internal oblique*, the *quadratus lumborum*[2], the *rectus*[3] and the *pyramidalis*[4]. The

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[1] In Fishes these diaphragms are chiefly formed, so far as they are represented at all, by the fascia alone. The sheet passing upon the bowel near the anus represented in Lepidosiren (Fig. 23) is the only representative of the pelvic diaphragm.

The post-cardiac diaphragm is wanting in Saurians as well as Ophidians (Stannius, 105). In some birds, as Apteryx, it is well developed in its crural, or vertebral, and costal parts, but is deficient in front, where the heart projects through it.

[2] This muscle is carefully described by Carus, Beiträge zur vergleichend. Muskellehre, *Zeitschrift für Zoologie*, III. He regards it as part of the ventrolateral system; he says it is absent in Birds, but present in Chelonians, Ophi-

complete segmentation of the *quadr. l.* from the stratum, above, and of the *rectus* and *pyramidalis*, beneath, is due to the sudden alteration in the direction of their fibres from that of the fibres of the *internal oblique*. The relations of this muscle to both are nearly the same, a layer of it being continued upon the superficial, and another layer upon the deep surface of each; and these layers, forming sheaths for the *rectus* and *quadr. l.*, are in contact, and more or less blended, with the superficial (external oblique) and deep (transversalis) strata of the ventral muscle.

In the thorax the middle stratum forms the series of *external intercostals*. The direction of the slant of the intercostal muscles might indicate the external layer to belong rather to the superficial, or external oblique stratum and the internal intercostals to belong to this middle stratum. But, as we have already found, the fibres in different parts of the same stratum are disposed in very variable directions; and the relations to the intercostal nerves and blood-vessels are stronger grounds for classing the external intercostals with the internal oblique and

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dians, Saurians and Batrachians; that in Man it sometimes passes to the body of the 11th dorsal vert. and to the 11th rib, in the Buffalo to the 4th hinder dorsal vert. and ribs. In some animals, as Hyrax (see Meckel), it advances still further forwards. In Cryptobranch its representative is not segmented from the rest of the ventral muscle, but, like that of the rectus, is continuous with it. In Pseudopus Pallasii it is distinctly a serial correspondent and extension of the intercostals passing from the hindmost rib to the iliac bone (p. 289).

[3] The relations of the *rectus* to the several strata of the ventral muscle vary a good deal. Primitively, as in Lepidosiren and most Fishes, it is continuous, and on a level, with the whole thickness of the ventral muscle. In Cryptobranch it is so with the middle and external strata only, while the internal stratum passes above it. In Snakes a deep part of it seems to be represented by thickening of the intercostal fibres near the extremities of the ribs. Some of these thickened bundles pass from rib to rib, and some from one rib to another at a greater distance. And in them, and more clearly in Pseudopus P. (p. 288), it, or the chief part of it, lies on a plane superficial even to the external stratum the fibres of which pass into its deeper surface. In Mammals it is completely segmented from all the strata, and lies in the greater part of its course between the layers of the middle stratum.

Müller, *Abhandl. der Berlin. Akad.* 1834, p. 345, and Tab. I, describes and represents the *rectus* as distinct from, and covered superficially by, the *obliqui* in Bdellostoma. This is, however, unusual in Fishes.

[4] The *pyramidalis* appears to have special relations to the marsupial bone, and to the spine and crest of the pubes, which are the representatives of that bone; and its presence as an independent muscle is probably to be associated with the tendency to the presence of this as an independent bone (footnote on p. 16). Functionally, it seems to assist in strengthening the suprapubic region of the abdominal wall; and it is well developed in animals (female Pteropus, *Journal Anat.* III. 301, and Pseudopus P., on page 289) in which, in consequence of an interval between the pubic bones, the *recti* muscles diverge and leave this part of the abdomen comparatively unsupported.

the internal intercostals with the transversalis stratum.—The *levatores costarum* which, like the external intercostals, are overlapped by the dorsal muscle, may also be ranged as members of the middle ventral stratum[1].

The *rectus* is usually continued forwards on the external surface of the sternum and costal cartilages, not unfrequently as far as the first costal cartilage, constituting a *rectus thoracis*. Other longitudinal muscles are sometimes (Aï, Cyclothurus, Otter, &c.) developed, lying also beneath (superficial to) the ribs, more laterally than the rectus, and constituting what may be designated *recti thoracis laterales*[2], to distinguish them from, and mark their relation to, the *rectus thoracis*. These muscles approach or alternate with extensions of the *scaleni* backwards. The *rectus* may (Cyclothurus and Otter) be crossed superficially by a *sterno-costal* muscle passing from the sternum, obliquely forwards and outwards, to the ribs and approaching the *scaleni*. All these belong to the middle or internal stratum of the ventral muscle and are merely illustrations of varying cleavage and segmentation in accordance with varying direction of fibres.

From the ribs the middle stratum is continued forwards laterally to the cervical transverse processes as *scaleni*. These are separated from the *rectus capitis* and *longus colli* of the internal stratum (p. 309) by the cervical nerves. As just hinted, they often extend upon the exterior of the ribs, meeting the *recti th. laterales* and the *sterno-costales*[3]. Anterior to the scaleni is the *rectus capitis lateralis*. Nearer the mesial line, inferiorly, the middle stratum is continued forwards to the hyoid[4], thyroid, tongue, jaw and pharynx as *sterno-hyoid* and *sterno-thyroid*, as *hyo-glossus* and *genio-hyo-glossus*, and as *hyo-* and *thyro-pharyngeus*, or middle and inferior *constrictors* of the pharynx. These come into relation with muscles ascending to, or descending from, the skull, which probably also belong to the same stratum, viz. *stylo-glossus*, *stylo-hyoideus* with the hinder portion of the *digastricus*[1], *stylo-pharyngeus*, superior *constrictor* of the pharynx, as well as the faucial and palatal muscles.

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[1] In Snakes, these last are much developed and extend over a greater range than in other animals, for the purpose of assisting in progression; and there is commonly to be found a series of internal *levatores costarum*, situated external to the outer part of the *depressores*, crossing those muscles and appearing in the interval between them and the *transversalis*. Their position would indicate them to belong to the internal stratum; but the nerves which lie external to the depressors and the transversalis, pass internal to the levators. It may be added that the nerves in these animals do not confine themselves to the intercostal spaces opposite which they escape from the vertebral canal, but, in some instances, cross over one or more ribs, passing between the ribs and the transversalis.

[2] One of these has been so named by Macalister, in his description of AI, *Annals and Mag. of Nat. Hist.*, June 1869.

[3] In the Green Monkey the *scalenus* is continued into the *rectus*.

[4] The inscriptions in the ventral muscle running forward to the hyoid,

From the outer surface of the middle stratum muscles are detached to the shoulder-girdle. Those passing to the part of the girdle above the glenoid cavity (the scapular part) constitute the *costo-scapular* or *serratus* group. They consist of one or more muscles attached to the ribs, interdigitating and sometimes connected by continuity of fibres with the external oblique, so as to present strong claims to be regarded as part of the same stratum with it; but in their course they are deep; and they are inserted into the deeper surface of the margin of the scapula, on one or two sides, between the *sub-scapularis* and the other muscles which are inserted into, or near, the margin of the scapula. Anteriorly, this group is prolonged into the neck as the *levator scapulæ* which is not unfrequently continuous with the *serratus*, and as the *omohyoid*[2]. The muscular

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present in Lepidosiren and others, are not unfrequently represented by one inscription near the middle of the sterno-hyoid. This inscription is continued into the omohyoid with which the sterno-hyoid is sometimes continuous; and it is usually persistent in the latter muscle, in Man, where it makes a bend towards the clavicle. Stannius speaks of an extension of the *rectus* to the tongue in Triton.

[1] In the Porpoise this part of the digastric only is present passing from the hinder part of the temporal to the hyoid. It is called occipito-hyoid by Rapp, *Die Cetaceen Zoologisch-anatomisch dargestellt*, s. 182, and by Stannius, *Müller's Archiv*. 1849, s. 7, but is regarded by Stannius as the posterior belly of the digastric. For account of the anterior part see page 324.

[2] The *omohyoid* may be, as in Phoca, continuous with the *sterno-hyoid*, forming a broad muscle inserted into the sternum, the ulnar tubercle of the humerus and a fascial band between the two. It may, as in Scinc, be attached to the clavicle as well as to the scapula; and the *sterno-hyoid* is in that animal attached to the interclavicle, or episternum. Tendinous traces of the clavicular attachment bend it towards the clavicle in Man, and are, partly or entirely, the cause of the persistence of the inscription or interruption in its muscular fibres. Though in the same plane with the *levator scapulæ*, it is separated from it by the situation of the branchial opening, which also separates the members of the superficial brachio-cephalic stratum (the sterno-mastoid and trapezius) that overlie this region. In the Hippopotamus it passes from the side of the basi-hyal and the sub-hyoidean septum to the under surface of the occipito-humeral part of the trapezius which it joins at an angle, and is united to it by an inscription. The foremost fibres run on without any definite inscription to

derivations from this layer, which pass to the girdle beneath the glenoid cavity, are the *sterno-* or *costo-coracoids*. When the coracoid is abortive, the *costo-clavicular*, called *subclavius*, may take the place of the *costo-coracoid*[1]; and when both coracoid and clavicle are abortive, the member or members of the group may pass to the under surface of the scapula, constituting the *costo-* or *sterno-scapulars*[2]. Thus, spreading beyond their usual limits, these may come into close relation with the serratus group. Or the serratus, extending lower down than usual, may come into close relation with the costo-coracoids. Still the two groups—the costo-scapular and the costo-coracoid or costo-clavicular—are, I believe, always separated by the nerves to the limb passing between them.

These two groups of muscles passing, respectively, to the scapular and to the coracoid or the clavicular parts of the shoulder-girdle, together with the muscles passing forwards to the hyoid, tongue and jaw, constitute that which I have designated (pp. 262, 285) the DEEP BRACHIO-CEPHALIC STRATUM of the VENTRAL MUSCLE. In animals (Snakes and Urodelans), in which the inferior wall of the thorax is not closed in by the sternum and the costal cartilages, the middle, or cephalic, part of the stratum may be continued onwards, uninterruptedly, to the hyoid and the mandible, but it is not segmented from the superficial stratum (Fig. 44 and description); or (Fishes, Figs. 26 and 38) it may be interrupted by the coracoids extending athwart the middle line and uniting with one another, and may then be segmented from the superficial stratum.

Traced backwards from the abdomen, the middle stratum

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the humerus. In the Pig it passes over the anterior edge of the scapula to the upper edge, and is connected by fibrous tissue with the radial tubercle of the humerus and the deltoid muscles.

[1] These two do not coexist, when the coracoid is large, the muscle passes from the sternum or rib to it, and forms a *sterno-* or *costo-coracoid*. When the coracoid is short the muscle, if present, passes from the rib, or the first or (Orycteropus) second costal cartilage and perhaps the sternum, to the clavicle constituting the *subclavius*. It may, as it does in Orycteropus and Scinc, extend on to the scapula. In the Porpoise the *subclavius* passes from the first rib, near the sternum, to the coracoid; and the *pect. minor* passes from the second rib to the humerus. Stannius, "Beschriebung der Muskeln des Tümmlers." *Müller's Archiv*, 1849, s. 14 and 16, calls the former of these *pect. minor*, and the latter *costo-humeralis*.

[2] The sterno-scapular may coexist with the subclavius. Thus Macalister found the subclavius quite separate from the sterno-scapular and inserted into the clavicle. In such case the muscle is divided into two.

of the ventral muscle encounters the pelvis and is interrupted by it[1]. Its continuations backwards from the pelvis constitute the *ilio-* and *ischio-caudales*[2], the deep *sphincter-ani*, the *erector-penis*, *compressor-urethræ* and *transversus-perinei*, besides the extensions upon the hind limb around the hip-joint to be subsequently mentioned.

I pass now to the disposition of the EXTERNAL STRATUM of the VENTRAL MUSCLE which has the external oblique muscle of the abdomen as its most steady representative, and which I, therefore, sometimes call the EXTERNAL OBLIQUE STRATUM. As already stated, it is the stratum in which the ossifications, not preceded by cartilage, most frequently occur. The 'membrane bones' thus formed are commonly in the situation of the septa, and, therefore, overlie the 'cartilage bones' formed in the septa of the middle stratum. Sometimes they are blended with them, the two being ossified together, or the one may serve as a substitute for the other. Thus the epicostals[3], the episternum[4] and the epicoracoid, or clavicle, are formed, respectively, over the costals, the sternum and the coracoid, and the lower jaw is formed over Meckel's cartilage. We have seen that this stratum is, in Fishes, closely connected with the skin by the transverse and longitudinal septa passing through the compact intervening external fascia.

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[1] It must not be forgotten, that the rudimentary pelvic bones of Ophidians lie, or rather project upwards, internal to the *transversalis*. Perhaps they originate in the internal oblique stratum, and grow through the transversalis, just as in many animals the ilium presents through the external oblique stratum, and as in the Dog-fish, the scapula pushes its way into the dorsal muscle (Fig. 28). In Pseudopus P., the ilium, though deep, is not quite so deep as in Snakes, a considerable part of the ventral muscle is inserted into, or interrupted, by it, and a distinct strip of the muscle passes beneath it (p. 289).

[2] The ischio-caudal, and the ilio-caudal are, to some extent, serially homologous, respectively, with the costo-coracoid, and the costo-scapular (*serratus m.*); and the nerves to the hind limb pass between them, as do the nerves to the fore limb between the last-named muscles.

The shoulder-girdle, like the pelvic girdle, varies in the depth at which it is placed, and also remarkably in the size of its coracoidal part, and in its connection with the rest of the skeleton above and below. In Fishes the coracoid part is imbedded in the deep stratum of the ventral muscle; but in Cryptobranch, the coracoid, notwithstanding its size, has little direct connection with the ventral muscle, the deep layers of which pass clear of it and above it. In Birds and Reptiles its connection with the deep ventral stratum is re-established by the costo-coracoid muscles. In Mammals the connection is chiefly, through the medium of the *pectoralis minor*, with a deep layer of the pectoral or superficial stratum of the ventral muscle.

[3] In Hatteria the epicostals are more numerous than the costals, occupying not only the lines over them, but the interspaces between those lines: see Günther, *Phil. Trans.* 1867, p. 608, whose description I have in most points verified.

[4] I much prefer the old term, 'episternum' to that of 'interclavicle', proposed by Mr Parker; because it expresses not only its position, but its nature as a bone formed in the membranous tissue upon the sternum, at the same time that it refers it to the same series as the epicostals and the clavicle.—It will be perceived that, for the same reason, I use the term 'epicoracoid' to designate, not the cartilage or cartilages lying between the coracoid and the sternum, but the

A superficial layer of the stratum is often, more or less completely, segmented from the rest, and, retaining its connection with the skin, or with the superficial fascia or both, constitutes cutaneous or subcutaneous muscles to which the names *pannicle*, *platysma myoides*, &c. are given. They may retain their original connection not only with the rest of the external ventral stratum, but also with the deeper strata, and with the cartilage bones. Thus they, in some instances, are united to the ribs and the sternum, the vertebral spines and the limb-bones. They often correspond, and are more or less blended, with the several divisions of the rest of the stratum, and will therefore be best considered in relation with them. They commonly extend over the lateral septum, spreading upon the dorsal muscle, and reaching the dorsal mesial line. This also we shall find to be the case with the rest of the stratum. Or, which is much the same thing, the components of this external stratum of the ventral part of the lateral muscle are confluent with superficial dorsal fibres, and form one stratum with them; so that it might be called the 'external ventro-dorsal', or, better, the 'external lateral' stratum, that is, the external stratum of the entire lateral muscle[1]. See Diamond Snake (Fig. 44)[2].

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membrane bone, or clavicle, formed upon it, and often in close connection with it.

[1] This extension of the external stratum of the ventral part of the lateral muscle, over the lateral line and over the dorsal part of the muscle, to the vertebral spines is due, perhaps, to the expansion of the visceral cavity, laterally and upwards, as seen in the section of the Tadpole (Figs. 42 and 43).

[2] Description of Fig. 44, Pl. xvi.—The DIAMOND SNAKE.

Dissection of the fore part of a Diamond Snake.—The pin is inserted into the fore part of the cerato-hyoid cartilage which is seen running back among the muscles. The drawing shews the bundles of the external oblique arising partly from the lateral septum, and partly from the fascial tissue on the surface of the dorsal muscle and passing, downwards and backwards, into the antero-posteriorly directed fibres of (*r.*) the rectus abdominis. Traced forwards, the rectus is seen giving off the bundles of the external oblique. Anteriorly, it expands into a muscular sheet, in the middle of the thickness of which the hyoid is involved. This runs forwards to the lower jaw, covers the under part and sides of the throat, expands upon the side of the head and neck, and extends over the dorsal muscle to the cervical spines. A set of its bundles more distinct than the others runs to the angle of the mouth, constituting a *retractor oris*.

This expansion is a continuation of the entire thickness of the ventral mus-

In the abdomen the stratum is chiefly represented by the external oblique which extends upon the exterior of the thorax, and the fibres of which often blend with the fibrous tissue over the dorsal muscle. Anteriorly, it is continued, or its superficial fibres are continued, with a variable amount of interruption, into a 'superficial brachio-cephalic' sheet which extends to the face and head, which is distorted by encountering the fore limb and its girdle, and the fibres of which converge upon the limb, as though, like the skin, they had been pushed before it as it grew out from its girdle. Hence, opposite the limb, the fibres are directed transversely, from the ventral and dorsal mesial lines, upon the limb; whereas, before and behind, they have a more oblique or antero-posterior direction.

As it advances towards the fore limb the inferior, or ventral, part of the superficial brachio-cephalic sheet resolves itself into the *pectoralis major*, the fibres of which converge upon the radial edge of the humerus, inclining to the plantar aspect; the superior, or dorsal, part of the sheet resolves itself into the *latissimus dorsi*, the fibres of which converge upon the ulnar side of the humerus, and are often, to some extent, blended with the muscles on the dorsal aspect of the limb. I say, to some extent, because the prolongations upon the middle and distal segments of the limb of both the inferior and superior parts of the sheet shew an inclination to the plantar aspect, which is a consequence of the position and flexures of the limb. The two—*pectoralis* and *lat. d.*—may (Lepidosiren, p. 259) be united and pass as a continuous sheet upon the radial and ulnar margins and upon the intermediate, plantar or axillary, that is, the posterior aspect, of the shoulder and limb. More commonly they are separated by the axillary interval; or, connecting axil-

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cle, and contains therefore the elements of all the muscles covering the under part and sides of the neck, and passing between the thorax, hyoid and jaw. It represents, in short, the whole of the brachio-cephalic stratum of Lepidosiren and Dog-fish,—the cervicalis profundus, that is, as well as the cervicalis superficialis;—and it includes therefore the factors of the sterno-mastoid and trapezius, the platysma, constrictor faucium, &c. A continuation of it backwards would represent the pectorals and latissimus dorsi as well as the serratus.

Though its hinder edge seems to be marked off from the oblique, yet its connection, and the connection of the oblique with the rectus, and the fact that the oblique bundles cease where this more continuous expansion begins, shew that it is a serial continuation of them, of the parts of them more especially which extend upon the dorsal muscles.

lary bands, may remain as a result of imperfect segmentation[1]. The term 'achselbogen' has been applied to them. The term 'axillary' is that by which I will designate them.

The *costo-alaris* (*costo-anconeus*) of the Bird is an interesting example of one of these 'axillary' muscles, being segmented from both the *pectoral* and the *latissimus dorsi*, and passing from the ribs, between the two, near to the *serratus*, along the inner side of the arm, to or near the inner condyle of the humerus. In the Swan I found part of it elastic, where it occupied the hinder fold of the axilla, and traced it along the ulnar margin of the wing, and in the retiring angle beneath the carpus, to the skin and tissue binding the skin to the ulnar phalanges. Thus it presents interesting antagonistic homological affinities to the *tensor plicæ alaris;* and by its near relation to the *serratus* on the deeper side, and by its blending with the cutaneous muscles and the skin on the superficial side, it is an interesting relic of the primitive union of the several strata.

The relation of this brachial, or hinder part, of the superficial brachio-cephalic sheet to the rest of the external oblique stratum varies a good deal. In many animals, for instance, the *pectoral* is a continuation of the whole thickness of the *external oblique*, or of the whole or great part of the *rectus*. In Cryptobranch it is almost entirely derived from these. In others, it is a superficial stratum only of the oblique, extending perhaps to the pubes. In others again it arises from the outer surface of the aponeurosis of the oblique; and in Hatteria it appears to arise from between its layers[2]. In Man it is usually continuous with the oblique by means of only a few muscular fibres. In the Hippopotamus it is largely continuous with the subcutaneous muscle over the oblique; whereas in Birds its origin is so confined to the sternum and the clavicle that we should little have thought of regarding it as an extension of the abdominal stratum, had our attention been limited to its anatomy in them. In like manner the *latissimus dorsi* is, in some, confined to the neural spines, in others extends upon the ilium; and, not unfrequently, it derives origin from the hinder ribs, where it may (Seal) meet, and be united with, the pectoral. In the Porpoise its origin is confined to the 5th, 6th and 7th ribs[3].

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[1] A good illustration of these axillary muscles was presented this winter by a female subject in the dissecting-room of this University. A slip from the lower edge of the *pectoralis*, and another from the anterior edge of the *latissimus dorsi* in each arm, ran through the axillary space and, meeting, were inserted together into the fascia covering the *coraco-brachialis*.

These connecting bands are commonly large in Carnivora. They are usually formed by an extension of the *latissimus dorsi*, or parts of it, beneath the axilla, to the pectoral muscle and the pectoral ridge of the humerus; while another part of the *lat. d.* runs along the inner side of the triceps to the inner condyle forming the *dorsi-epitrochlien*.

[2] *Phil. Trans.* 1867, p. 609. In Pteropus, *Journ. Anat.* III. 300, it is in three separate parts, an abdominal, a sternal, and a clavicular.

[3] The variation in the mode in which cleavage of strata may take place is illustrated by the fact, that in Birds and Reptiles the *lat. d.* usually overlaps the

All this hinder, post-brachial, portion of the external stratum of the lateral muscle may be covered by a superficial, or subcutaneous, layer, which varies much in thickness, and which may be connected with one or all of the divisions of the stratum, sometimes reciprocating with them in size and thickness, as in the Hippopotamus. Like them it converges upon the arm; and, accompanying the pectoral more particularly, it may be lost in that muscle, or it may be inserted into the humerus or the coracoid.

It is often a muscle of such size, and of so powerful action upon the arm, and radiates from the arm so widely upon the flank, that I have[1] described and named it as *brachio-lateral*. Sometimes it, or part of it, lies upon and is closely united with the *latissimus dorsi;* or it may be (Hatteria) continuous with its lower edge. Sometimes (Manis) it is difficult to separate from the skin on the one side and the external oblique on the other[2]. As mentioned above, it forms part of the *costo-alaris* of the Bird.

Traced forwards into the pre-brachial or cervical region the SUPERFICIAL BRACHIO-CEPHALIC STRATUM, which we are considering, is, after a certain interruption caused, partly, by the shoulder-girdle, and, partly, by segmentation from alteration of the direction of its fibres, continued as a superficial cervical sheet —*cervicalis superficialis.* It covers the neck, from the shoulder-girdle to the skull, and from the ventral median line to the

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trapezius, the reverse being the case in Mammals. In the Rabbit the two muscles are continuous.

[1] *Journ. Anat.* IV. 27.

[2] The superficial, cutaneous layer is well developed in the Porpoise, where it spreads upon the fins, under the abdomen, and under the sheath of the penis; and in the female it passes beneath the mammary gland, detaching fibres which encircle the lower dilated part of the duct, so as to compress it during suckling. It attains its maximum in the Hedgehog, being connected with the frontal and occipital bones, the lower jaw, sternum and humerus, and the dorsal and caudal spines, and forms a thick sphincter around the body beneath the line where the bristles terminate.

In the Guinea Pig both *pectoral* and *trapezius* are continuous with the pannicle. In the Pig, and many Animals, the brachio-lateral part extends over the thigh. In the Hippopotamus it is very largely developed, forming a thick mass over the abdominal muscles, which are almost dwarfed or supplanted by it, though quite distinct from it; it extends over the thigh and the knee; and it is also continued into the pectoral.

In Snakes the continuity of strata is manifested and maintained by the bundles of the oblique abdominal muscles passing from the ribs directly into the ventral scutes, which are thus enabled to act as organs of locomotion. Some of the bundles running horizontally for a distance, from scute to scute, constitute (pp. 313, 327) a superficial or subcutaneous *rectus.*

lateral line; and it commonly extends, in a muscular form, beyond the lateral line, to the dorsal median line. Anteriorly, it is connected with the whole circumference of the skull, and sends superficial prolongations over it. It is well exhibited in Lepidosiren (Figs. 24 and 26), Dog-fish (Figs. 28 and 29), and Ceratodus (Figs. 34 and 37), and I have named the ventral part of it, lying beneath the level of the gills, *cervicalis superficialis inferior* (*C. s. i.*), and the dorsal part of it, lying above the level of the gills, *cervicalis superficialis superior* (*C. s. s.*). These two parts are, however, continuous upon and above the gill-cover; and the superior or dorsal portion (*C. s. s.*) seems rather to be an extension from the inferior or ventral portion (*C. s. i.*), just as the ventral and dorsal portions of the post-brachial part of the same stratum are often continuous, and the latter seems to be an extension from the former.

In animals like those just mentioned, where there are gills with the attendant opercular structures, the *cervicalis superficialis* is but a thin expansion, and does not present any distinct segmentation beyond that—often not very distinct, into *levatores, depressores,* &c. *arcuum*—which is requisite for the movements of the branchial apparatus. Where, however, the gills are abortive it acquires increased thickness and is stratified and segmented.

A superficial layer forms the *subcutaneus colli* or *platysma* which covers the neck and is prolonged forwards upon the face and head, where it blends with and is continued into the facial muscles, the auricular muscles and the *occipito-frontalis.* It is prolonged backwards upon the thorax and fore limb to an indefinite extent, blending with the *brachio-lateral* and, like it, finding its way to the osseous structures of the limb. As in the case of the *brachio-lateral,* portions of it may blend with, or supplant, segments of the subjacent layer.

In some instances it is continuous with the *trapezius*; and in Pteropus it takes the place of the cervical portion of that muscle[1]. A remarkable detachment from between its dorsal and its ventral portions, blended with a similar detachment from the deeper layer (from the contiguous edges of the pectoral and *trapezio-deltoid*), forms the *tensor plicæ alaris*, better called *cervico-alaris*. This, partly composed of elastic tissue, extends along the radial edge of the wing in Bats and Birds, and reaches the skin and subcutaneous tissue of the radial digits. It is thus (as mentioned p. 319) the antagonistic homologue of the *costo-alaris*.

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[1] Macalister finds that the muscle, which thus in Bats supplants the cervical part of the *trapezius*, is supplied not by the spinal accessory, but by cervical nerves and the seventh nerve.

The deeper layer of the *cervicalis superficialis* developes into the *sterno-cleido-mastoid* and the *trapezius*, the former representing the ventral, or sub-branchial, part of the layer, and the latter representing the dorsal, or supra-branchial part[1]. They are very regular muscles, but vary in their range of attachment at both ends. The *sterno-cleido-mastoid* is sometimes confined to the sternum and then is called sterno-mastoid. Sometimes it is inserted, by a narrow tendon only, into the mastoid, instead of by a broad musculo-tendinous termination as in Man[2]. Sometimes the portion connected with the clavicle is separate, forming a cleido-occipital. The *trapezius*, instead of the extensive origin from skull, cervical and dorsal spines, overlapping the *latissimus dorsi*, which it has in Man, may (Pteropus and Birds) have much more limited origin. It may, in the absence of the clavicle, be inserted (Cryptobranch) into the anterior edge of the scapula and the precoracoid or (Aï) the coracoid; or it may be continued as trapezio-deltoid to the humerus[3]. When this last occurs, there is usually an inscription remaining between the *trapezius* and the *deltoid*, in the deeper part of which a rudimentary clavicle is often present in Carnivora.

From beneath the *trapezius* the *rhomboids*[4] are segmented,

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[1] The interval between the two in Racoon is partly bridged over by fibres passing from the trapezius to the sterno-mastoid, reminding us of the epi-branchial fibres connecting the *superior* and *inferior cervicales* parts in Lepidosiren and Dog-fish.

[2] In a Fawn I found it extending over the lower jaw to the orbital edge of the maxilla, occupying that part of the area of the superficial layer. In Crocodile it passes beneath the *trapezius* to the transverse process of the 4th cervical vertebra, where it comes into contact with the middle ventral stratum represented by the *levator scapulæ*.

[3] In Manis it extends over the *biceps* and brachial vessels to the internal condyle of the humerus.

[4] The *rhomboid* in Owl and Kite extends from all the lumbar and dorsal spines to the hinder edge of the scapula, dwarfing the *trapezius*. In Apteryx it is said by Owen to be wanting. It is present in the Crocodile, but I have not met with it in any lower animal; sometimes it blends with the *latissimus dorsi*. *Journ. Anat.* IV. 33.

also apparently the *serrati postici*, as well as the *masto-humeral* and *masto-scapular.* Though the last two might perhaps be said to be segmented from the deep surface of the sterno-mastoid, yet they usually blend below with the trapezius or deltoid, or pass to the scapula or humerus. Also another muscle is segmented from the trapezius, which I have in former papers named *cervico-humeral,* and which is an interesting reminder of the fact that in Lepidosiren (p. 260) and Dog-fish (p. 274) some of the deeper fibres of the layer are traceable to the lateral septum and, beneath it, to the lateral parts of the vertebræ; for the *cervico-humeral* arises, not like the *trapezius* from the vertebral spines, but from the transverse processes of the atlas or other cervical vertebræ, near to the *levator scapulæ,* or even (Hedgehog) from the fore part of the ring of the atlas, or (Guinea Pig and Rabbit) from the basi-occipital. It descends upon the shoulder to the clavicle, acromion, or humerus, or blends with the trapezius or deltoid. Thus, though it is associated with the *levator scapulæ* in its origin, it is associated with the *trapezius* in the latter part of its course; and it is evidently a representative, in Mammals, of those fibres of the stratum which, in Lepidosiren, detach themselves from the rest of the stratum and bend in, deeply, to the sides of the vertebræ. In the Hippopotamus the *cervico-humeral* arises by a round tendon from the back of the exoccipital, behind the digastric and stylo-hyoid, joins the *trapezius,* forming its fore part, and runs on to the deltoid ridge of the humerus. It is not separated from the deltoidal, or lower, part by any inscription. It is joined by the omo-hyoid which loses itself in this muscle. It is called masto-humeral by Gratiolet. A separate large portion arises by a strong tendon from the under surface of the transverse process of the atlas and spreads upon the dorsum of the scapula. The *trapezius* passes over the large transverse process of this vertebra without deriving any fibres from it.

Between the two layers of the cervical part of the superficial brachio-cephalic stratum, just described—the *superficial* layer which is forming the *subcutaneus colli,* and the deeper layer which forms the *sterno-mastoid* and *trapezius*—other muscles are developed in different animals, to which the names *cervici submaxillaris*, *depressor mandibulæ*, *mylo-hyoideus* and *genio-hyoideus* are given. These vary a good deal; and the first two are absent in higher animals. I have said that they are found between the two layers; but the genio-hyoid, which lies near the middle line, is perhaps rather to be regarded as segmented from the deeper surface of the superficial layer. The most remarkable member of this series is the anterior belly of the digastric. It lies in a more superficial plane than any, yet is continued, through the medium of a tendon or inscription, into the posterior belly which runs, in company with the stylo-hyoid, beneath the sterno-mastoid, to a deeply situated spot of the temporal bone, just behind the styloid process.—The peculiar conformation and disposition of this muscle in Man, and the inscription which in many lower animals is substituted for the tendon between its two muscular portions, have excited much attention and been the cause of many surmises. I believe the real explanation of it to be that it is composed of two muscles or muscular portions derived from the two strata of the brachio-cephalic muscle. The hinder portion is, together with the stylo-hyoid, a derivative from the deep stratum, which it will be remembered is an extension of the middle or internal oblique stratum of the ventral muscle; and the anterior portion is a derivative from the fibres of the *cervicalis superficialis* layer, which lies next above the *subcutaneus colli*. It is an instance of a portion of a deep stratum retaining continuity through the medium of a septum with a portion of a superficial stratum. The septal remnant, which is a remnant of the hyoidean, or sub-hyoidean, septum (the septum, that is, in which the hyoid is formed), is the tendon of connection between the two portions and the band which holds them to the hyoid[1].

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[1] It may be observed, as affording some confirmation of the relation described in the text between the anterior belly of the digastric and the mylo-hyoid, that they are both supplied by the mylo-hyoid branch of the 5th nerve; whereas the posterior belly of the digastric and the stylo-hyoid are both supplied by the 7th nerve. I do not however attach much importance to this.

In this derivation of the digastric from the elements of deep and superficial strata, we are reminded of the same thing in the *cervico-humeral* just mentioned, and in the *costo-alaris* (p. 319).

The dissection of the Hippopotamus[1] (Figs. 45 and 46) affords an interesting illustration and confirmation of these views. The *subcutaneus colli* (*S. c.*) under the neck is of great thickness, as is the case with the subcutaneous muscles on the under surface of the body generally; and it appears at first sight to terminate in front in a thick defined border extending, on either side, upon the middle of the large mandibular protuberance into which the masseter (*M*) is inserted. The muscle at and near this border is further thickened by transverse fibres crossing from one side of the face, over the mandibular protuberance, to the other side. Close examination, however, shews that the anterior border is not so defined as at first sight appears; for the edge is connected by fibrous tissue, which is the sub-hyoidean septum[2], with deeper-lying muscle, a broad, thick *hyo-mental* (*A. M.*), which passes forwards, from the septum just mentioned, to the mandible on the side of the bulging symphysis. By means of this septum the *hyo-mental* is continuous, behind, with the superficial fibres of the *sterno-hyoid* (*St. H.*) which is a large thick muscle, on its deeper surface, with the basi-hyoid bone, and, on its superficial surface, with the edge of the *subcutaneus colli*[3]. Above it, and deeper than it, is the *mylo-hyoid* (*M. H.*) Above this is (*G. H.*) the *genio-hyoid*, and deeper still is the *genio-hyo-glossus*. These are disposed as they usually are in Mammals. The *stylo-hyoid* arises, tendinous, from the outer side of the tooth-like exoccipital process, soon expands into a muscular belly which is, partly, inserted into the hyoid, on a level with the mylo-hyoid and the genio-hyoid and, partly, is continued on into the lateral edge of the hyo-mental. The *digastric* (*D'*) arises, by a tendon, from near the extremity of the same process as the stylo-hyoid, passes internal to the stylo-hyoid, expands into a belly which, about on a level with the hyoid, is interrupted by a transverse inscription[1]. In front of this (*D*) it runs parallel, and on the same level, with the hyo-mental and is inserted, behind the hyo-mental, and continuously with it, into the lower edge of the body of the jaw, midway between the symphysis and the angle.

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[1] Description of Figures of the HIPPOPOTAMUS and the CAT (Pl. XVI.).

Figs. 45 and 46. Dissections of the muscles beneath the floor of the mouth of a Hippopotamus which died three days after birth.—*I. M.*, the inferior maxilla, with its large submental protuberance uncovered.—*L*, the upper lip.—*S. c.*, subcutaneus colli.—*M*, Masseter.—*H. M.*, hyo-mental entire on the left side, but divided on the right side, and, in Fig. 46, reflected.—*D.*, anterior part of digastric running parallel with, and blended near the jaw with, the hyo-mental.—*M. H.*, mylo-hyoid divided and partially removed to expose *G. H.*, the genio-hyoid.—*F. A.*, the facial artery.—In Fig. 46, the subcutaneus colli has been removed, exposing the hinder part (*D′*) of the digastric, also *S. H.*, the stylo-hyoid which is seen to be continuous with the hyo-mental.—*St. M.*, sterno-mastoid.

Fig. 47.—Similar dissection in Cat. *S. c.*, the subcutaneus colli, or platysma, has been divided and pulled aside to shew (*D* and *D′*) the anterior and posterior parts of the digastric, with the inscription between them which is the sub-hyoidean septum. The anterior part of the digastric is seen to occupy the position occupied by the hyo-mental, as well as by the anterior part of the digastric, in the Hippopotamus.—*M. H.*, the mylo-hyoid.—*St. H.*, sterno-hyoid.

[2] It is called by Gratiolet, *Recherches sur l'Anatomie de l'Hippopotame*, p. 246, the *raphé-sous-hyoïdien.*

In the Flying Squirrel Macalister found that the digastric had two separate bellies and a central round tendon which was continued across, from side to side above the hyoid bone, as an arch from which the anterior bellies arose. This tendinous arch was the sub-hyoidean septum. I have met with a similar arrangement in the body of a man, in the University dissecting-room, this winter.

[3] Gratiolet (p. 299) describes it as *le second faisceau* of the digastric. It is in the plane of the digastric; its mandibular insertion is blended with the insertion of the digastric, and it occupies the place of the anterior belly of that muscle in Man. A *hyo-mental* is present in some Bats, according to Macalister.

The facial artery (*F. A.*) passes, as usual, beneath the stylo-hyoid and digastric, and runs along the outer and posterior side of the digastric, over the side of the jaw, between the digastric and the fibres of the masseter which are curling round the anterior border of the protuberance to be inserted into its inner side and edge.

The points shewn by this dissection are, first, the connection of the *subcutaneus colli* with, and its termination at, the hyoidean septum. Secondly, the presence of a hyo-mental muscle superficial to the mylo-hyoid, extending from the hyoidean septum to the symphysis of the jaw, and the continuity of some of the fibres of the *stylo-glossus* with it. Thirdly, the position of the anterior belly of the *digastric* (*D*), in front of the inscription, on a level with, and on the side of, a part of the same stratum with the hyo-mental, and, indeed, continuous with that muscle, and forming a lateral portion of it. It is clear that the inscription in the digastric is a part of the sub-hyoidean septum, and that the hinder, deeper, belly (*D'*) of the digastric is, by the medium of this inscription, continued into the lateral part of the hyo-mental, which forms the anterior belly; just as some of the fibres of the stylo-hyoid are continued into the middle part of the same muscle. In Man the lateral portion of this hyo-mental is absent; and it is the median portion which forms the anterior belly of the digastric. Hence the insertion of the digastric is near the symphysis of the jaw. The shifting insertion of the digastric into the jaw is thus explained by the circumstance that its anterior belly may be formed by different parts of the hyo-mental in different animals; and the inscription, usually observable, even when the muscle is straight, indicates the line of connection of the portion of the deep, or masto-hyoid, and the superficial, or hyo-mental strata which combine to make up the muscle. The hyo-mental portion, anterior to the inscription, or remnant of the sub-hyoidean septum, is a part of the superficial brachio-cephalic stratum; and the masto-hyoid portion, behind the inscription, is a derivative from the deep brachio-cephalic stratum.

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[1] Gratiolet, whose account corresponds in other respects with that in the text, observes that the muscular fibres are not interrupted by any tendinous inscription. It is, however, quite distinct in the young (8 days old) animal from which my description is taken.

In the Cat (Fig. 47), as in many others, the *digastric* is a straight muscle, slightly constricted and crossed by a distinct inscription where it passes the hyoid, with which it is unconnected. Then it expands to be inserted into the whole of the inner surface of the body of the mandible between the symphysis and the masseter. There is no *hyo-mental.*

It is worth while to remark that the hyo-mental in the Hippopotamus is, together with the anterior belly of the digastric, supplied by the mylo-hyoid branch of the fifth nerve which runs between them and the mylo-hyoid muscle.

In the limbless Saurians (Pseudopus, P.) the *rectus abdominis*, which forms the median part of the superficial stratum of the ventral muscle in the abdomen, is not separated from the cervical (*sterno-mastoid*) part by an intermediate, thoracic, transversely disposed (*pectoralis*) part, but is continued directly on into it, or with only some interruption of the deeper fibres by the clavicle. In Snakes the foremost bundles of the external oblique muscle arise from the mastoid process, and run backwards towards the ventral scutes beneath which they form a superficial *rectus*. Thus they represent the sterno-mastoid muscle in the same manner as do the corresponding fibres in Pseudopus P. For a short distance near the head the *obliquus* is overlaid by a superficial, thin muscular sheet extending from the cervical spines to the mandible and the scutes immediately behind it. This is described as being divided into *cervici submaxillaris* and *depressor mandibulæ*; and it corresponds evidently with part of the *cervicalis superficialis* of Lepidosiren and Dog-fish. But it is not interrupted by branchial openings; and it is not segmented from the subjacent layers of the ventral muscle, at least it does not present a stratification from them; although such separation may be indicated by the presence of the hyoid in the thickness of the sheet (see Fig. 44 and description[1]).

Traced backwards the superficial (external oblique) stratum of the ventral muscle is continued upon the hind limb, with more or less interruption by the limb-girdle; and it ensheaths the femoral segment much in the same manner as the humeral segment of the fore limb is ensheathed by a projection of the anterior prolongation of the stratum[2]. Ventrally, it is continued

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[1] Some of the fibres of this—the *cervici submaxillaris*—part of the stratum are described by Prof. E. d'Alton (Beschriebung des Muskelsystems eines Python bivittatus, *Müller's Archiv*, 1834, s. 355) as attaching themselves to the hyoid, forming a 'Nackenzungenbeinmuskel.' He also describes a 'Rückwartszieher' of the hyoid running obliquely and superficially from the cervical spine to the hyoid. Some fibres of the cervici- or masto-submaxillaris attaching themselves to the quadrate, he calls 'Zurückzieher' of that bone. It is an extension of these upon the mandible which forms the *depressor mandibulæ*.

[2] In certain Snakes the ventral muscles form a funnel-shaped process investing the base of the claw, which is the counterpart of the funnel-shaped

into the *gracilis*, which is, manifestly, a serial repetition of the *pectoralis*, and which, like that muscle, is chiefly attached to the pre-axial edge of the limb. Dorsally, it is continued into the *gluteus maximus*, which is the serial repetition of the *latissimus dorsi*, and which, like that muscle, is attached to the post-axial edge of the limb and blends with the dorsal muscle (the *quadriceps*) on the first segment of the limb. Both these muscles (*gracilis* and *gluteus*) incline to the plantar surface of the middle and distal segments of the limb, as do the *pectoralis* and *latissimus dorsi* in the fore limb, and for the same reason. The middle part of the external oblique layer is continued into the *tensor vaginæ femoris* and the *sartorius*, which are the representatives of the *deltoid* muscle, and which are cut off, wholly or in part, from the *obl. ext.* by the ala of the ilium, as the *deltoid* is wholly or in part cut off from the *trapezius* by the spine of the scapula. The opposed edges of the *sartorius* and the *gracilis*[1] are not commonly so approximated to each other as are those of the *deltoid* and *pectoralis*. In the interval between them, as well as upon them, the oblique muscle is continued into the fascia of the thigh; and the thickening called 'Poupart's ligament' at the crural arch, where the oblique passes into the femoral fascia, is probably a remnant of the pelvic septum; and an ossification in it would form the serial homologue of the clavicle[2].

These muscles and fasciæ are sometimes covered by an extension of the brachio-lateral muscle (p. 320), which may (*Pteropus*) acquire an attachment to the femur; just as in

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investment carried upon the fore limb of higher animals and segmented into *pectoralis*, *latissimus dorsi*, and *trapezio-deltoid*. Commonly the interruption of the components of the stratum by the pelvic girdle is greater than that by the shoulder-girdle. Thus the *gracilis* is often quite separated from the rest of the ventral muscle; though in some animals, as Cryptobranch, its continuity with the caudal and abdominal parts of the stratum is sufficiently clear: whereas the *pectoralis* is usually to some extent, and often very extensively, continuous with the external oblique, or the rectus, or both. So, the *sartorius* and *tensor vaginæ femoris* are rarely (they are in Aï) continuous with the external oblique; though the *deltoid* often is continuous with the *trapezius*.

[1] In the Rabbit the *sartorius*, arising from Poupart's ligament, is continuous with the *gracilis*.—In Aï, Manis, Pig, and others, the *sartorius* and *tensor v. f.* are continuous with the *gluteus;* and in Pig the *biceps* also is continuous with them.

[2] Probably the marsupial bone, formed from cartilage in the deeper part of this septum, corresponds with the sternal end of the clavicle, which, its epiphysial nucleus at any rate, is formed in cartilage.

the fore limb the subcutaneous muscle dips down to and is united to the humerus.

Behind the limb the external stratum is continued upon the tail and there blends with the middle stratum. Its superficial or subcutaneous layer forms the external *sphincter ani.* In some animals (Hedgehog) it is firmly inserted into the caudal vertebræ.

The following is a review of the serial or successional homological relations of the parts of the external stratum of the ventral muscle thus far discussed. The *gluteus max.* is serially homologous with the *latissimus dorsi.* The *tensor vag. f.*, the *sartorius*, the *femoral fascia* and part of the *obl. ext.*, with the *deltoid* and *trapezius;* Poupart's ligament representing the clavicle, and the ala of the ilium representing the spine of the scapula. The *gracilis* with the *pectoralis major.* The middle part of the *external oblique* and the superficial fibres of the *rectus* with the *sterno-cleido-mastoid*, and (between the sterno-mastoids) with the *mylo-hyoid*, the anterior belly of the *digastric*, the *hyo-mental* and the superficial fibres of the *sterno-hyoid.* The *rhomboids* and *serrati postici* have no homological representatives; and there are no structures in the tibial and fibular borders of the hind limb sufficiently segmented to compare with the *tensor plicæ alaris* and the *costo-alaris;* though the *sartorius* or some of its fibres nearly corresponds with the former, and the *caudo-pedal* with the latter. The *external sphincter ani* may be said to be serially homologous with the *orbicularis oris;* but the subcutaneous muscles generally do not admit of homological comparison.

The relations of the ventral muscles to the alimentary tube are therefore as follows:—The internal stratum is gathered round, continued into and reflected upon it as *levator* and *retractor ani* and is gathered round it as post- and sometimes as pre-cardiac diaphragm. The middle stratum forms the internal *sphincter ani*, and is continued into the tongue as *genio-hyo-glossus* and *hyo-glossus*, and is continued upon the pharynx as *thyro-* and *hyo-pharyngei* or *constrictores.* The external stratum forms, by its superficial layer, the *orbicularis oris* and other circum-oral muscles, and the *sphincter ani externus.*

The disposition of the ventral muscle in these three, oblique and transverse, planes is a visceral feature, is co-extensive, that is, with the visceral region or nearly so. It extends from the anus to the head, but not behind the anus, even in Bdellostoma, Snakes and other limbless animals. When the limb-girdles are present, either with or without the limbs, the planes are broken up by and partially lost on them; and when they are not present the planes are blended in the caudal muscles. In the Porpoise the *recti*, and with them the *obliqui interni* and the *transversi*, diverge and pass, on the sides of the bones supposed to be rudimentary pelvic bones, to the transverse vertebral processes in which they terminate about on a level with the vent; while the *obl. externi* terminate in a defined edge a little in front of the bones just mentioned. It will be understood that the stratification is no necessary accompaniment of the visceral region. It does not usually take place there in Fishes; and in higher animals it is often obscure or imperfect in certain parts, rendering it difficult or impossible to decide with certainty from which of the strata a given muscle is derived.

MUSCLES OF THE LIMBS.

IT has already been shewn that limb-girdles are, like the ribs and costal cartilages, formed in the transverse intermuscular septa of the ventral muscle, and in that part of the thickness of the septa which is in the plane of the middle or internal oblique stratum. They sometimes grow through the outer stratum and project subcutaneously; and the pelvic bone in Snakes lies, beneath the internal stratum, in juxta-position with the fascia transversalis. Essentially, however, they belong to the middle stratum; and the muscles passing from them upon the limbs may be regarded as derivatives from this stratum, as serially homologous, that is, with the muscles passing from septum to septum, or from costa to costa, in front and behind them.

It has also been shewn that the external stratum—the stratum of the external oblique muscle—is prolonged upon the limbs in the form of a more or less complete funnel-like investment of each limb. This is seen in its simplest condition in the Snakes that are possessed of claws. It is also well seen in Lepidosiren, where it consists of a simple sheath, interrupted, it is true, in front, by the branchial opening, yet surrounded by and extending along the fin; and different forms of it are exhibited in different animals. There are, therefore, derivatives of the two outer strata of the ventral muscle, at any rate, contributing, and largely, to the muscular basis of the limbs.

A limb is usually composed of a series of cartilaginous or osseous pieces serially arranged and moveable upon one another, of which the fin of Lepidosiren is one of the simplest examples; and the instance of the paddle of Ceratodus has shewn that the muscular fibres pass from piece to piece, indeed that the muscular tissue of the limb is, in the primitive form, segmented into transverse planes corresponding with the axial cartilaginous, or osseous, segments, thus resembling the disposition of the muscles in the trunk, and more particularly in the tail, of simply constructed animals. But, as we have found in the trunk, the muscular fibres, the superficial fibres more particularly, are often not confined to their particular segments. They commonly break through the intervening barriers, or intermuscular septa, and range on to more distant segments, blending with the muscles of those segments. Hence the muscles of any division of a limb consist, usually, of three layers. *First*, and deepest, are the fibres of the segment itself, the 'intrinsic' fibres; of these the proximal series are the bundles passing from the girdle to the first segment of the limb: *secondly*, the fibres derived from distal segments, the 'extrinsic' fibres; and *thirdly*, and most superficially, the fibres derived from the ventral muscle, the superficial 'ventro-appendicular' fibres. The components of these three layers are blended together in a variety of ways, rendering it often difficult or impossible to distinguish to which layer they appertain.

In the simplest condition, as that of Lepidosiren, the cartilaginous or osseous pieces of the limb are joined to one another by simple tissue, and are moveable in any direction; and the muscular fibres are uniformly disposed around the joints, the deepest, or 'intrinsic', fibres forming a sort of circular capsule, and being blended on the exterior with the 'extrinsic' and the 'ventro-appendicular' fibres. When movements in particular directions are required, the conformation and structure of the joint is proportionately modified, and the muscular fibres are arranged and segmented, more or less distinctly, into bundles or muscles to effect the object. In the case of the proximal joint of the limb—that of the first cartilage or bone with the girdle—the movement is, on the whole, circumductory or in any direction; and the muscles are disposed around the joint in a nearly circular manner. Usually, however, even here, certain movements take place more frequently or more freely than others; and the muscular fibres are accordingly arranged in groups, or muscles, having more or less independent action. In the distal parts of the limb the movements are commonly much more restricted, are limited indeed, nearly or quite, to one plane, which is, speaking generally, the same for all the joints of the limb. They all admit of flexion towards the palmar or plantar or ventral aspect, and of extension towards the dorsal aspect. Supposing the limbs stretched, as in their primitive condition, horizontally in straight lines and at right angles, from the trunk, then all the joints admit of flexion towards the ventral surface of the trunk and of extension to the horizontal line. At the wrist and ankle the extensor movement may, in some animals, be carried beyond that line (in Man the foot has come to be placed at a right angle with the leg); and the same is the case at the joints with the girdles where, as just said, other movements are also permitted. In all the joints, however, except that with the girdle, the movement is nearly restricted to the plane indicated. Hence the muscles are arranged in two sets, one upon the 'flexor' or 'ventral' aspect, which may also be called 'palmar' in the fore limb and 'plantar' in the hind limb, and the other set upon the 'extensor' or 'dorsal' aspect; and there is, speaking generally, a corresponding arrangement of the nerves.

It must not, however, be supposed that the arrangement is rigidly adhered to. Marginal portions of the ventral series occasionally (witness the *lumbricales*) stay upon the dorsal aspect and serve as extensors; and more frequently marginal portions of the dorsal series incline over the sides and upon the ventral aspect and serve as flexors, and perhaps become united with the flexors.

That there is a similarity, a general homological correspondence, between the muscles of the fore and of the hind limbs, as well as between the limbs of different animals, is self-evident. Their outer sheets are projections of serially homologous portions of the ventral muscle carried upon similar outgrowths from serially homologous ossifications in the ventral intermuscular septa[1]. The dorsal muscles of one limb and in one animal correspond, though not unexceptionably, with the dorsal muscles of the other limb and in other animals; and the same with the ventral series. There is, moreover, often an antagonistic similarity between the ventral and dorsal muscles, according with the similarity in the action requisite to produce the flexor and the extensor movements. In short, the similarity of muscular disposition about the several joints, in the same or the different limbs of the same or different animals, is, as we might expect, generally proportionate to the similarity of the form, movements and position of the joints and of the force required[1]. Differences in these are sometimes, indeed not unfrequently, associated with such varieties in the combination of embryonic germs as to defy attempts at an exact homological comparison.

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[1] The septa in which the corresponding limb-girdles are formed are not, numerically, the same in the different orders of vertebrates. The scapular girdle, for instance, in the Fish is developed in a septum close to the head; whereas in the Bird it occupies a septum far removed from the head. So, the position of the pelvic girdle, though presenting a steady relation to the hinder part of the visceral cavity and the termination of the alimentary canal, varies greatly in its distance from the scapular girdle, owing to the variation in the number of intervening muscular and intermuscular planes in different animals.

Two important features of difference which serve to modify the muscular relations in the two limbs at once suggest themselves as being present to a greater or less degree in most animals. First, the superficial position and the mobility of the shoulder-girdle, as compared with the pelvis; and associated with these are the variability and instability of the subglenoid parts of this girdle, and the frequent presence of a clavicle. The shoulder-girdle and its muscles often, indeed commonly, deviate from their simple primitive form and relations much more than do the pelvic-girdle and its muscles; and they are liable to much greater variations in position—fore and aft and in the depth of plane at which they are situated—and in their relation to the other parts of the osseous skeleton. In one animal the shoulder-girdle is joined to the head, giving it, in the opinion of some anatomists, a claim to be regarded as an appendage to the skull; in another animal it is joined to the vertebral spines; in a third to the vertebral bodies; in a fourth to the sternum; and in a fifth it is free from all these. These varieties in the girdle involve a greater amount of variety in the muscles connecting it with the rest of the trunk and passing from it to the limb, than is the case with the muscles of the pelvis. There is, however, in connection with the latter, the varying development of the tail, which leads to considerable variation in the muscles passing between this part of the body and the pelvis and hind limb.

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[1] I do not mean to assert that all muscular varieties are thus teleologically determined; but it is very generally so; and it is not easy to adduce unquestionable exceptions.

The second great feature of difference is the difference in the rotation of the two limbs; the dorsal surface of the thigh and knee being directed forwards, while that of the arm and elbow is directed backwards[1]. In the hind limb the leg and foot are involved in the same rotation as the thigh and knee. But the forearm and hand undergo a rotation in a different direction to that of the arm by means of the proation of the radius; so that the dorsal surface of the hand is directed the same way as the dorsal surface of the foot. The effect of these rotations is that the radial—or pre-axial—edge of the humerus looks outwards, and the tibial—or pre-axial—edge of the femur looks inwards. This leads to a difference in the insertion of some of the otherwise homologous muscles at the upper ends of the two bones, for instance, the radial tubercle of the humerus presenting on the outer side of the limb, receives the muscles from the dorsal aspect of the scapula and exceeds the ulnar tubercle in size; whereas the fibular tubercle of the femur rises into strong relief beneath the dorsum of the ilium, and receives the muscles which arise from that surface and exceeds the tibial tubercle in size.

I may observe that such a variation in the locality of the insertion of corresponding tendons in the two limbs, and indeed in the same limb in different animals, is by no means uncommon. It is seen in the instances of the extensor muscles of the leg and forearm, in the *extensores carpi radiales*, the *biceps brachii*, *latissimus dorsi*, &c. Too much importance has, I think, been attached to the insertion of a muscle as a guide to its homology: and the statement that the insertion is more to be depended upon, in this respect, than the origin is scarcely supported by observation.

We have already (p. 327) traced the ventro-appendicular muscles from the ventral muscle to the limbs, and pointed out their serial homological relations. It remains to follow them upon the limbs. Normally, or primitively, they spread, as in Lepidosiren, and less distinctly in Ceratodus, over the whole surface of each limb, forming an outermost muscular covering of the limb; and they are still seen to expand upon the distal segments in many even of the higher animals, especially in the hind limb. But they are often reduced, in their course down the limb, to fasciæ or areolar fibres, and often are arrested by insertion into a projecting process of bone at some higher point; or they blend with, and are lost in, the subjacent strata.

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[1] See my *Obs. on the Limbs of Vertebrate Animals*, p. 16.

To take first the 'palmar' and 'plantar', that is, the 'ventral' divisions of the ventro-appendicular muscle, which we call, respectively, *pectoralis* and *gracilis*. Each extends along the pre-axial edge of its limb, inclining to the palmar, or the plantar, surface. Each reaches sometimes to the distal segment, but is usually interrupted or lost earlier; and each blends in variable degrees with the subjacent muscles. The *pectoralis* is commonly arrested at the radial tubercle of the humerus; but, sometimes (Orycteropus), part of it accompanies the *biceps* to the radius, or (Otter and Wild Cat), together with some fibres of the trapezio-deltoid, accompanies the *brachialis anticus* to the ulna, or (Seal) expands into the fascia of the forearm and so reaches the hand. It is, in some instances, free from the subjacent muscles, and in others is blended with the coraco-brachials, or is connected with them by means of the *pectoralis minor* (see p. 344). The *gracilis* is rarely, if ever, arrested at so early a point as the pectoral. It is commonly inserted into the tibia, occasionally (Pteropus) blending with the *semitendinosus*, and, now and then (Unau and Aï), joining the *biceps flexor cruris* and acquiring an attachment to the fibula. It often extends down the inner side of the tibia, over the ankle and foot, spreading upon the dorsal and plantar surfaces of the foot (Seal). It is in some instances free from the subjacent adductors; in others (Cryptobranch) it is scarcely segmented from them.

The 'dorsal' divisions of the ventro-appendicular muscle have often a wider range than the 'ventral' both in their connection with the trunk and in the area of the limbs which they cover; and they are commonly sectorially segmented in some degree. The dorsal surface, as seen most distinctly in the fore limb of Dog-fish (Figs. 28 and 30) and in the hind limb of Ceratodus (Fig. 34), and the post-axial edge of the limb, may be regarded as their legitimate destination; but they not unfrequently spread, over both the pre-axial and the post-axial edges, upon the ventral surface of the limbs. They are, consequently, attached to various points. In the cylindrical (Lepidosiren), or rudimentary (Snakes), state of the limbs, they are not segmented from the palmar and plantar portions of the sheet, and are not themselves longitudinally or sectorially cleft.

In the fore limb there are usually two sectors of the dorsal division; one—the *trapezius*—converging from the dorsal aspect of the head and of the front of the trunk, and the other—the *latissimus dorsi*—converging from behind, upon the limb. The *trapezius* sector in branchiate animals (pp. 259, 273) is interrupted and devoted to the gill apparatus, and scarcely reaches the limb. In some animals, devoid of gills (Cryptobranch), it does not extend beyond the anterior edge of the scapular and the coracoid parts of the girdle. In others (certain Mammals) it runs on to the radial tubercle of the humerus, or to the radius, or even (Otter[1]) to the ulna, joining the flexors of the forearm. It usually presents an inscription as it passes over the shoulder. This inscription is the superficial part of the septum in which the girdle is formed; and, in Mammals, the anterior edge of the scapular part of the girdle, called the 'spine', commonly grows through the septum, so occupying the inscription, and bisecting the upper or supra-scapular part of the muscle, transversely, into posterior, or *deltoid*, and anterior, or *trapezius* parts. In the lower, or coracoidal, part of the septum the case is somewhat different. Sometimes the inscription (*i. e.* the remnant of the septum in the muscle) remains, and marks the division into *trapezius* and *deltoid* parts. Sometimes it is nearly obliterated. Sometimes it becomes ossified into a 'clavicle' or 'epi-coracoid' (p. 316), the ossification being (many Carnivora) confined to the deeper tract of it and limited in extent, or extending through the thickness of the muscle, and ranging, from the acromial end of the spine of the scapula, to the sternum[2]. The most important varieties, therefore, in this trapezio-deltoid sector are; *first*, that in which it does not extend below the anterior edge of the girdle; *secondly*, that in which it extends beyond the edge of the girdle and its septum down to the humerus or forearm; *thirdly*, that in which it is divided transversely, in part or the whole of its width, into two distinct muscles by ossification extending from the edge of the scapular part of the girdle into the septum which traverses it and by ossification arising independently over the coracoidal part of the girdle. The portion of the *trapezius* which, in Cryptobranch, is inserted into the anterior edge of the scapula is, in Mammals, continued, beyond that edge, which grows up as the spine, into the scapular portion of the *deltoid;* and the portion which, in Cryptobranch, is inserted into the coracoid is, in Mammals, continued, beyond the coracoidal septum, or the clavicle which may form in it, on into the clavicular portion of the *deltoid.* These two portions of the *deltoid* are not unfrequently separate.

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[1] In an Otter the foremost fibres of the *trapezius*, continued as *deltoid* with an intervening inscription, and accompanied by some fibres of the *pectoralis*, descended in front of the *brachialis anticus* to the ulna.

[2] In Lizards the clavicle extends along the anterior edge of the scapula to its base. In Aï it is attached to the coracoid. In Fishes it is large, closely applied upon the coracoid, and meets its fellow in the middle line; but it is not certain that ossification ever extends from the coracoid into it. It seems in this respect to bear to the coracoid somewhat similar relations to those which the supra-, or better epi-, scapular bones (Parker's supra-clavicles) bear to the scapula. I have spoken of the clavicle as an ossification in one of the muscular septa of the brachio-cephalic stratum, corresponding with the epicostals. But it should be added that it is situated at a deeper level than they, in the deeper

The sector in the hind limb, corresponding to the trapezio-deltoid, is recognisable as a distinct element only behind the pelvic girdle, where it forms the *sartorius* and the *tensor vaginæ femoris.* These are usually cut off from the *external oblique* part of the ventral muscle lying in front of them, which, or part of it, may be supposed to correspond to the *trapezius*, by the edge of the ilium; and they thus answer, serially, to the scapular portion of the deltoid. The *sartorius* is sometimes (Unau and Aï), like the *deltoid,* inserted into the pre-axial edge of the first bone of the limb; but, usually, it runs into the second bone. In other words, the *sartorius* usually continues its course on to the tibia, but is occasionally arrested at the femur[1]; whereas the *deltoid,* or part of it, occasionally (Orycte-

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instead of in the superficial part of the stratum, as seen in Ps. Pallasii, and also in Carnivora, where the rudimentary clavicle is found in the deeper part of the septum between the trapezius and the deltoid. It has not unfrequently connections with the muscles of the subjacent stratum—the *subclavius* and the sterno- and omo-hyoids. It is extended between two cartilage bones, of which one (the sternum) is in a deep level. According to Gegenbaur, it is not without claim to a cartilaginous origin itself at one part; and it has a cartilaginous epiphysis. In short, it appears to afford an example of remarkable blending of the superficial membranous and the deeper cartilaginous ossifications, the former preponderating from a very early period, and in some instances, probably, constituting the only basis of the bone.

[1] The *sartorius* sometimes (Hippopotamus) runs down the middle of the dorsal aspect of the thigh, over the patella, and is lost there. In the Heron it

ropus) continues its course on to the radius, but usually is arrested at the humerus. The course of the *tensor v. f.* into the fascia does not distinctly correspond with anything in the fore limb. It is present only in Mammals, and is often wanting in them. The *sartorius* may (Rabbit) extend, along Poupart's ligament, to the *gracilis*, as the *deltoid* often extends, along the clavicle, to meet the *pectoral*. This is, however, rare; and the intermediate space between the two muscles in the retiring angle of the bend of the groin, where there is no 'point d'appui' for muscular action, is usually occupied by fascia. That fascia is, accordingly, the serial representative of the clavicular portions of the pectoral, deltoid, and trapezius, Poupart's ligament being the serial septal representative of the clavicle.

The posterior sector of the dorsal portion of the ventro-appendicular muscle in the fore limb—the *latissimus dorsi*—is, like the pectoral, a very general appurtenance to the fore limb in animals above Fishes. Even in Fishes it is sometimes (Dog-fish, Fig. 28) represented by a thin stratum segmented from the ventral muscle and passing upon the dorsum of the fin, the pectoral being in like manner segmented and passing upon the palmar surface of the fin. In Lepidosiren (Fig. 24) we have seen the *latissimus dorsi* and the *pectoralis* travelling forwards as a continuous sheet constituting the hinder part of the superficial brachio-cephalic stratum. In this animal the *latissimus dorsi* is attached to the scapular part of the girdle in addition to passing upon the fin; and in Dog-fish it is barely segmented from the deeper (*serratus*) part of the stratum which is also attached to the scapula. In Man, and some other animals, it still retains the scapular connection; and, as before (p. 319) remarked, it often retains its connection with the pectoral by axillary bundles passing from it to that muscle. It is traceable to variable points in the limb. In Lepidosiren its fibres run on with others to the extremity of the fin. In Urodelans it is blended with the *triceps;* and more or less of this union is often found in Mammals. In Saurians and Birds it passes, between the scapular and humeral origins of the triceps, to the radial edge of the humerus. In Mammals, passing internal to the tri-

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is more separate from the *gluteus* than in most Birds, and some of its fibres are traceable into the *gastrocnemius*.

ceps, it is inserted into the ulnar edge of the humerus, sending often a *dorsi-epitrochlien* down to the ulnar condyle, or (Cyclothurus) extending along the fascia of the forearm to the ulnar side of the carpus[1], or (Manis) running into the *flexor sublimis digitorum*, or (Rabbit) into the *flexor carpi ulnaris*.

This muscle thus affords a very interesting illustration of the varying points at which a ventro-appendicular muscle becomes arrested in different animals, and the varying muscles of the deeper strata with which it becomes blended or, rather, with which it retains its connection.

It is worthy of remark that the fibres of this muscle, and also of the pectoral and, though less frequently, those of the deltoid, often cross one another in a remarkable manner; those which arise most posteriorly passing behind the others to an insertion in front of them, so causing a sort of twisting or folding-in of the lower edge and, sometimes, leading to a cleavage in the plane of the muscle. I have before called attention to this point (p. 296 and *Journal of Anat.* IV. 35).

The corresponding sector in the hind limb—the *gluteus maximus*—has relations as varying as those of the *latissimus dorsi*. Its connection with the ventral muscle is well exemplified in Dog-fish (Fig. 30), and Ceratodus (Fig. 34), as well as the mode in which, in a primitive condition, it extends upon the limb, and blends with the proper muscles of the limb[2]. From these animals upwards the connection with the ventral muscle rarely reappears[3]. Thenceforwards its chief attachment is to the ilium (which appears through the ventral muscle like the spine of the scapula) and to the neural spines and arches of the caudal vertebræ. In the lower animals it is often, as we have seen in Cryptobranch, so united with the *extensor cruris* as to be with difficulty distinguished from it; and in Birds it blends with that muscle in the thigh. The same connection exists, to a greater or less extent, in Mammals; though sometimes, as in Man, the connection is with the fascia covering the *quadriceps*. Like the *latissimus d.* it is, in addition, often inserted into the post-axial line of the femur; but it does not follow its homologue by occasionally passing, between the divisions of the extensor muscle, to the pre-axial line. It sometimes ranges along the margin of the ilium to unite with the *tensor v. f.* and the *sartorius*, so obliterating the division between the two sectors; and on the limb it often reaches the fibular malleolus and side of the foot.

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[1] Representing the *costo-alaris* of the Bird (p. 319).

[2] It is not quite correct to speak of the muscle referred to in these animals as the *gluteus* sector only; forasmuch as it represents, rather, the entire undivided dorsal portion of the ventro-appendicular sheet. In Mammals also it is often undivided.

In anourous Batrachians and Saurians, this dorsal portion is a not distinctly segmented muscle.

[3] In Manis the dorsal portion of the ventro-appendicular muscle is largely developed, blending above with the external oblique and reaching to the lumbar spines, and below extending over the buttock and the fore and outer parts of the knee and thigh.

Before concluding the account of the ventro-appendicular muscles, it is necessary to mention certain derivatives from the ventral muscle of the tail which belong to this series, some of which are not represented in the fore limb.

Of these, the first and most superficial is that which I named *Caudo-pedal* in the description of the Cryptobranch. It occupies an intermediate position between the *gluteus* and the *gracilis*, and descends along the plantar surface of the limb to the distal parts, blending with the flexors of the digits. In Fishes it is not distinctly represented; and in animals above Reptiles it is lost or represented only by fascial tissue in its upper part. Its lower part in these animals is probably represented by the *plantar fascia*, or the superficial layers of the plantar fascia, and, perhaps, by the superficial layers of the *tendo-Achillis* and by some fibres of the *gastrocnemius*. In the fore limb of Birds it seems to be serially represented by the *costo-alaris*, or its superficial fibres, which, as I have before said, is the antagonistic homologue of the *cervico-alaris* (*tensor plicæ alaris*). Such antagonistic homologue to the caudo-pedal in the hind limb we do not find. It would be represented by fibres from the external oblique, between the *sartorius* and the *gracilis*, passing down to the distal region of the limb[1].

Beneath, and connected with, the caudo-pedal is the *caudo-crural* of Cryptobranch, which fuses with the adducto-flexor mass passing to the leg, and more particularly with that part of it which represents the *semitendinosus*, thus giving rise to, or causing the persistence of, an inscription which I have (p. 19) supposed to represent the inscription found in that muscle in Man and some Mammals[1]. The only trace of serial homologue in the fore limb to the caudo-crural would be fibres of the hinder portion of the pectoral, or fibres of the oblique or rectus, joining the biceps brachii. But none of them so coalesce with that muscle as to cause an inscription in it.

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[1] In Crocodiles a large muscle passes from the hindmost projecting point of the ilium; and at the ham its tendon is, partly, connected with the deeper muscles and, partly, extends superficially down to the foot. A segment of it internally joins the *gracilis*. Externally, it is in contact with the *biceps* and *gluteo-rectus*. I suppose it is the representative of the *caudo-pedal*, starting from the ilium as a fixed basis instead of from the caudal vertebræ.

Both the caudo-pedal and the caudo-crural lose the transverse inscriptions where they separate from the ventral muscle in the tail; but there is in the retiring angle between the tail and the hind limb in Saurians a thick transverse fascial band, which I suppose to be an inscription between the caudal and the crural parts of these ventral, or ventro-appendicular, muscles, and which seems to correspond, antagonistically, with Poupart's ligament, and so, serio-antagonistically, with the clavicle.

Still deeper, and belonging to a deeper plane, is the *caudo-femoral*, which is usually present in ovipara above Fishes, and is sometimes designated *agitator caudæ*. It is inserted into the femur, and is, in varying degrees, blended with the deep muscles of the thigh—the *adductors* and the *semimembranosus*—and sometimes with the origin of the flexors of the foot and toes, affording an interesting example of the prolongation of the deeper strata of the ventral muscle to the distal parts of the limb.

The caudal derivations, which form so important an element in the muscular system of the hind limb of Urodelans and some Reptiles, are present, though less strongly developed, in Birds, and are not uncommonly met with in Mammals. Thus the *semitendinosus* sometimes derives its chief origin from the sacrum. In the Otter and Racoon, the *caudo-crural* is more distinctly represented by a muscular slip derived partly from the spinous and partly from the transverse processes of the caudal vertebræ. It joins the hinder surface of the *semitendinosus*, and is prolonged with the posterior fibres of that muscle to the inner side of the heel. The caudo-femoral is also represented in the Otter by a thin muscle, arising from the transverse processes of the caudal vertebræ, passing internal to the sciatic nerve, and into the middle third of the linea aspera, between the gluteus and the adductors and distinct from both. The *pyriformis* and *quadratus femoris* muscles are both present in this animal. In the Rat a caudo-femoral muscle passes from the sacrum, beneath the *gluteus*, to the internal condyle and the post-condyloid bone, between the *addr. m.* and the *semimembranosus*. It lies near to, and in the same plane with, the *ischio-caudal*. The antagonistic homologues of the two (*caudo-femoral* and *ischio-caudal*) are probably the *psoas magnus* with its neighbour the *psoas parvus*.

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[1] In some large-tailed Mammals (Cyclothurus and Manis) the *semitendinosus* retains the caudal as well as the pelvic factors. I have not, however, found the inscription in any of these.

THE MUSCLES PASSING FROM THE LIMB-GIRDLES TO THE LIMBS

may be regarded as extensions of the deeper strata of the ventral muscle—as deep ventro-appendicular muscles—forasmuch as the girdles are ossifications in the deeper level of the ventral inter-muscular septa. They share the surface of the girdles with the fibres of the ventral muscle which pass backwards or forwards to the adjacent trunk segments. Hence the extent of their attachment to the girdles varies inversely with the extent of attachment of the direct fibres of the ventral muscle. Where the latter are numerous, as on the ilium of Cryptobranch, the muscles passing from the bone to the limb are few. Where, on the contrary, the range covered by the direct ventral fibres is small, as in the pubischium of Cryptobranch, the size of the muscles passing to the limb is considerable. In like manner the extent of their attachment to the first segment of the limb reciprocates with that of the origin of the muscles passing to the second segment. Thus, in Cryptobranch, the *pectineus* engrosses the whole of the dorsal surface of the femur; whereas in most animals that surface is occupied by the extensor of the leg, and the *pectineus* is compressed within narrow limits. It may be inferred that the corresponding embryonic factors are, in some instances, employed in the building up of the one series of muscles and, in other instances, of the other series.

These muscles surround the joint of the first limb-segment with the girdle in a more or less circular, or capsular, manner. Usually, however, they are arranged in two divisions, or groups, in each limb. The one group passes from the outer, or posterior, surface of the girdle, beneath the joint, to the ventral or under surface of the limb, constituting a palmar or coraco-humeral series in the fore limb and a plantar or pubischio-femoral series in the hind limb. The other group passes from the outer, or hinder, surface of the girdle, above the joint, to the dorsal surface of the limb, constituting a dorsal or scapulo-humeral series in the fore limb, and a dorsal or ilio-femoral series in the hind limb[1]. These groups do not adhere strictly to their respective limits. They sometimes extend from the outer surface, over the margins, upon the inner surface of the girdles; and they sometimes extend from the area of the girdle beneath the joint to the part above it, and *vice versâ*. Moreover, in accordance with the difference in the rotation in the two limbs, the insertion of corresponding muscles may be on the one—the pre-axial or radial—side in one limb, and on the opposite—the post-axial or fibular—side in the other limb. It not unfrequently is found, in the case of each of the several groups, that it is imperfectly segmented from the superficial ventro-appendicular stratum on the one surface, and from the muscles which pass on to the next segment of the limb on the other surface.

In animals above Fishes the CORACO-HUMERALS, or, as they are more generally called, CORACO-BRACHIALS, are commonly divided into segments which vary in number and size with the number and size of the coracoid processes; and they are sometimes absent when these processes are abortive, as in Mole, Cyclothurus and Seal. They arrange themselves in two divisions. *First*, those which lie superficially with regard to the *biceps brachii* muscle and which pass to the radial tubercle of the humerus immediately above the level of the *pectoralis major* and also extend beneath that muscle. These constitute a superficial or pre-axial division. *Secondly,* those which lie beneath the *biceps* and pass to the ulnar tubercle and ulnar side of the humerus. These constitute a deep or post-axial division.

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[1] These are seen in their simplest form in Ceratodus (Fig. 34), where the coraco-brachial and the scapulo-brachial muscles are seen extending from the respective parts of the girdle upon the ventral and dorsal surfaces of the pectoral fin. The arrangements are similar in the hinder fin; and there are additions from the ventral muscle.

The superficial division comprises the *epicoraco-humeral* and the *precoraco-humeral,* and probably the *supra-spinatus,* the *levator humeri* and the *pectoralis minor.* All these, with the exception of the last, which I will consider separately, may, I think, be regarded as parts of one muscle which occupies, essentially, the precoracoid process and might be called the precoraco-humeral muscle. It may spread upon the edge of the coracoid on the one side, and be segmented, so forming an *epicoraco-humeral;* and it may spread upon the supra-spinal space of the scapula on the other side, so forming a *supra-spinatus.* In Cryptobranch (p. 52), where the precoracoid processes are large, the *precoraco-humeral* muscle is well developed; and the *epicoraco-humeral,* in the same plane with and scarcely segmented from it, spreads over the edge of the coracoid; but there is no *supra-spinatus.* In Menobranch the latter muscle is present, in addition to the other two; but its edge is continuous with that of the *precoraco-humeral.* In the Scinc the *precoraco-humeral* and the *supra-spinatus* are large and separate; but there is no *epicoraco-humeral* extension of them over the broad origin of the *biceps.* In the Crocodile the *precoraco-humeral* is large, arising from the precoracoid process—from the outer surface and the anterior edge, and also from the deeper surface of that process—much as the *pectineus* often arises from the corresponding surfaces of the pubes. It is nearly on a level with *pectoralis* on the one side, and the *deltoid* on the other, and is inserted between them. The *supra-spinatus* is small, lies partly beneath it, and is imperfectly segmented from it. There is no distinct *epicoraco-humeral,* the surface of the coracoid, internal to the origin of the *biceps,* being closely covered by the *pectoralis* which derives some fibres from its edge, from the place, that is, where the *epicoraco-humeral* usually arises. In the Bird the precoracoid process does not run out distinctly. It is bent down with the coracoid to the sternum, forming an acute angle with the sternum; and the *precoraco-humeral* muscle follows it, together with the *epicoraco-humeral* factors. These, or some of them, extend upon the sternum and form the *levator humeri* or *pectoralis tertius*[1], as it is sometimes called. In Mammals the *supra-spinatus* and the *pectoralis minor* are the representatives of this division.

The fibres of the epicoraco-humeral part of this superficial, pre-axial, or supra-bicipital, division of the coraco-humerals lie immediately beneath the *pectoralis major* in its whole course. I have remarked that in Cryptobranch its superficial fibres are blended with the under surface of the pectoral, and that in Crocodile the fibres that correspond with it form part of the origin of the pectoral. It thus, to some extent, occupies the place of the *pectoralis minor;* and if we suppose it continued upon the under surface of the pectoral, and in variable degrees segmented from that muscle, it would quite correspond with the ordinary mammalian *pectoralis minor,* the proper insertion of which appears to be the radial ridge or tubercle of the humerus. It is, however, in Man and some animals, arrested wholly, or (Rat), partially, at the coracoid and is often quite segmented from the *pectoralis major.* Thus, I conceive the *pectoralis minor* to be formed from factors of the *pectoralis major,* which, or some of which, represent the *epicoraco-humeral* of Urodelans, Reptiles and Monotremes, and that it also in part represents, indeed is the nearest representative of, the *levator humeri* of Birds[2].

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[1] Also the *secundus* when both are present.

[2] This view is in accordance with the fact that the *levator humeri* sometimes absorbs the *supra-spinatus*, or derives an accession of fibres from the upper surface of the scapula, as well as with the occasional passage in Man, as noted by Macalister, Wood and others, of the *pectoralis minor* over the coracoid process beneath the coraco-acromial ligament where it has been found to blend with the *supra-spinatus*, or with the capsule of the joint, or to pass directly to the head of the humerus. It harmonizes also with the close relation of the *supra-spinatus* to the tendon of the *biceps*, a relation corresponding with that of the *epicoraco-humeral* to the *biceps* in Urodelans and Reptiles.

It however is not quite in accordance with the view of Prof. Rolleston, *Trans. Linn. Soc.* xxvi. 609, that the *subclavius* is the homologue of the *levator humeri*. I have before (p. 315) given reasons for thinking that the *subclavius* is an extension of the middle stratum of the ventral muscle and is the serial homologue of the *costo-coracoid* muscle. It lies in front of, or above, the costo-coraco-clavicular ligament; and when it is prolonged beyond the range of the clavicle, it usually expands upon the *supra-spinatus* or the dorsum of the scapula, forming the *sterno-* or *sterno-costo-scapularis*, as it does in Hippopotamus and some other animals. Sometimes, however (Pig), it reaches the radial tubercle of the humerus; but its destination is rather to the dorsum of

The deeper, post-axial, or sub-bicipital, coraco-humerals arise from the coracoid beneath the biceps, as best seen in Reptiles. They may be traced, in these animals, taking origin from the under and hinder surface of the coracoid and spreading upon the under surface of the scapula, where a portion of them forms the *subscapularis*. In Mammals, this muscle is quite segmented from the others[1]. They are inserted into the ulnar edge of the humerus; it is inserted into the ulnar tubercle. The one next below the *subscapular*—the *coraco-br.-medius*—is generally present and is inserted into the middle of the shaft. The passage through it of the external cutaneous or musculo-cutaneous nerve indicates a tendency to division; and in several Mammals (Rabbit, Proboscis Monkey and Jerboa) the upper segment is inserted separately into the ulnar tubercle, forming a *superior coraco-brachial*. In Amphibians, Reptiles, and Monotremes there is commonly a third segment, an *inferior coraco-brachial*, which extends to the ulnar condyle; and the brachial artery with the median nerve passes between it and the middle coraco-brachial.

The PUBISCHIO-FEMORALS are less variable in number and size than their homologues just described, owing to the greater uniformity of the pubic and ischiatic bones in comparison with the coracoids. Like the coraco-humerals, they arrange themselves into superficial or pre-axial and deep or post-axial divisions, which pass, respectively, to the tibial and fibular edges of the femur; but the two are not so separated at their origin by the intervention of the prolonged portion which forms the flexor of the leg, as the two divisions of the coraco-humerals are separated by the prolonged portion of them which forms the *biceps* flexor of the forearm.

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the scapula than to the humerus in the instances in which there is no clavicle, or when it extends beyond that bone.

The *pectoralis minor* would seem to be conducted as it were to the thorax in Mammals by the costo-coracoid ligament which usually separates it, above, from the subclavius, and which may be, as suggested by Gegenbaur, a remnant or representative of the extension of the coracoid to the sternum in ovipara.

In Pteropus (*Journ. Anat.* III. 301) a deep portion of the pectoral, which may be the *pect. minor*, arises from the clavicle. In the Rabbit, besides being connected with both tubercles of the humerus, it spreads over the *supra-spinatus*, and is inserted along the whole length of the spine of the scapula.

[1] In the Dog the *subscapularis* is partly blended with the *supra-spinatus*, and in the Mole with the *teres major*.

The superficial, or pre-axial, division of the pubischio-femorals comprises muscles arising from the os pubis (which is probably the representative of the precoracoid), and from part of the surface of the ischium (which is probably the representative of the coracoid). Owing to the large relative size and fixity of the bones from which they arise, and the heavier work which usually devolves upon the hind limb, they are ordinarily larger and more numerous than their correspondent the *precoraco-humeral* with its appendages, the *supra-spinatus* and the *epi-coraco-humeralis*, in the fore limb.

The *pectineus* is perhaps the most constant segment or muscle of the division, and it answers in many respects, serially, to the *precoraco-humeral.* It arises from the os pubis, and not unfrequently extends, over the anterior edge, upon the deep surface of the bone, much as the *precoraco-humeral* in Crocodile extends, over the anterior edge of the precoracoid, upon its deep surface. We have found the *pectineus* in Cryptobranch spreading over the dorsal surface of the femur, even to its fibular side. Usually, however, its insertion is limited to the upper part of the tibial line of the femur (the tibial edge of linea aspera). Where the ala, or anterior edge of the ilium, grows into prominence, an extension of this pubischio-femoral division spreads upon and occupies the anterior, or deeper, surface of the ala, constituting the *iliacus internus*[1], in the same way that an extension of the superficial coraco-humerals spreads upon the anterior surface of the spine of the scapula, and constitutes the *supra-spinatus.* Behind the *pectineus* lies the *adductor* mass, which is variously segmented in different animals and which is perforated by a vessel that in some animals becomes the main vessel of the leg and foot. It sometimes (Hippopotamus, Fig. 48, and others) extends upon the tibial side of the leg; and, we shall find presently, it often has intimate relations with the flexors of the leg[2].

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[1] In Saurians the *iliacus int.* ranges, like the *pectineus* in Cryptobranch, but to less extent, over the dorsal surface of the femur, approaching the fibular side. In Mammals it is restricted to the tibial side.

[2] The adductor mass not unfrequently extends across the popliteal surface of the femur to the fibular line of the linea aspera; and a considerable part of it is probably derived from factors which, in the fore limb, range themselves with the post-axial division of the coraco-brachials.

The view just given of the morphological relations of the *iliacus internus* derives perhaps some confirmation from the fact that in the Hippopotamus, and other artio-dactyles and some other animals, there is an extension into the pelvis of one of the superficial muscles of the thigh—the *ilio-prétibien* of Cuvier. At least near the knee this muscle lies in the plane of the *sartorius* and the *gracilis* and seems, in some instances, to belong to the one, and in some, to the other of these two. In a Hippopotamus[1] the muscle I am alluding to was, near the knee, joined with the *gracilis*. Ascending, it diverged from it and divided into two portions. Of these, one was inserted into the inner edge of the brim of the pelvis, blending there with the lower part of the *psoas parvus*. The other portion expanded over the *iliacus internus:* the middle part of this was lost in the fascia covering that muscle; and the lateral parts, separating fork-like, approached and blended with the *psoas parvus* near its origin, on the one side, and with the outer fibres of the *iliacus int.* on the other side[2]. The *pectineus* was not distinctly segmented from the *adductors* in the Hippopotamus.

A remarkable derivation from this series of muscles, and apparently from the *pectineus*, is the *internal rectus* of Saurians and Birds. In the Cryptobranch we noticed the *pectineus* extending over the dorsal surface and fibular side of the femur; and the *internal rectus* would seem to be an extension of the lowest part of this, over the knee, beneath the *quadriceps*, into continuity with the flexors of the digits, an extension similar to that of a portion of the *peroneus*—the *p. longus*—over the ankle, through the sole, to the metacarpal of the hallux, or to that of the *tibialis anticus*, in Unau, over the inner side of the foot, into the flexor of the digits.

The deep, or post-axial division of the pubischio-femoral mass, which is inserted into the fibular edge of the femur and the fibular trochanter, is segmented into the *quadratus femoris*, the *gemelli*, and the *obturator externus* and *internus*. The

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[1] Fig. 48 represents the muscles of the fore and upper part of the thigh and of the front of the pelvis, in a young Hippopotamus. *Il. i.*, iliacus internus.—*Ps. p.*, psoas parvus.—*Ps. m.*, psoas magnus.—*N*, the anterior crural nerve.—*I. p. t.*, ilio-prétibien.—*Ad. l.*, adductor longus.—*Gr.*, gracilis.—On the right side, the gracilis and ilio-prétibien have been removed, bringing into view more fully the psoas magnus, the iliacus internus and the adductor longus, also shewing (*Ad. m.*), the adductor magnus passing to the tibia, and (*S. t.*) the semitendinosus.—*S.* the sartorius.

[2] This extension upon the *iliacus* is described by Gratiolet in his *Mémoire*, p. 287, as the *Sartorius*. There is, however, a muscular band passing from the ant. spine of the ilium over the front of the patella, which appears to represent the *sartorius* and the *tensor vag. femoris; occasionally* the *gracilis* itself extends over the *pectineus*, and so comes into relation with the *ilio-prétibien* above, as this muscle comes into relation with the *gracilis* below.

obturator internus appears to result from an extension of the mass round the posterior edge of the ischium upon its internal surface, resembling the extension which we not unfrequently find of the *pectineus* upon the internal surface of the pubes; and the two divisions of the pubischio-femoral mass may thus meet on the internal surface of the pubischium. This extension of the *obt. int.* corresponds serially with the extension of the coraco-humeral mass upon the posterior and inner surface of the coracoid, a prolongation of which (p. 346) beneath the scapula forms the *subscapularis* and corresponds with the prolongation of the *obt. int.* beneath the ilium.

Instead of saying that the *obturator internus* is formed by an extension of the pubischio-femoral mass round the edge of the ischium upon its internal surface, it would be more correct to say that the fibres of the ventral muscle developed upon the inner surface of the pubischium blend posteriorly with, and so form an extension of, those on the outer surface. We sometimes find that they take a different direction, and blend with the muscles in front of the pubischium. Thus in Saurians they join the members of the pre-axial division and, uniting with the *pectineus* and *iliacus internus*, create an extension of those muscles in that direction. Again in Birds they take a third course and, converging to the fore part of the obturator foramen, run forwards, through it, to the fibular condyle.

This remark is applicable to other instances in which I speak of an extension of a given muscle over any particular territory. That extension is commonly effected by the fibres which belong to and are developed in the territory mentioned blending with the muscle which is extended over it. Accordingly, it will be commonly found that the nerve-supply to the so extended part of the muscle is derived from the sources which appertain to the region which it covers. I do not therefore attribute much importance to the fact of the internal obturator muscle being associated in its nerve-supply with the gemelli and quadratus, while the external obturator muscle is in the same way rather associated with the adductors and the gracilis.

The SCAPULO-HUMERAL and ILIO-FEMORAL muscles are, respectively, situated upon the dorsum of the scapula and of the ilium, and are, in the main, inserted into that surface of the proximal part of the limb, in each case, which is directed dorsally. This, in the primitive piscine condition of the limb (see Dog-fish and Ceratodus), is the dorsal surface. In most higher animals, however, the radial tubercle and edge of the humerus, and the fibular tubercle and edge of the femur, are turned into the position most favourable for their reception[1].

In the fore limb the scapulo-humeral mass is, in most of the lower animals, represented by a single muscle, diffused upon the dorsal surface of the fin in Fishes, but in Urodelans and Reptiles converging into a tendon implanted into the radial edge or tubercle of the humerus and called *dorsalis scapulæ*. This in higher animals is commonly segmented into *infra-spinatus, teres minor,* and *teres major*. It is probable that some of its superficial elements, which in certain cases apply themselves to the last-named muscles, in other cases apply themselves to and contribute to the formation of the *deltoid*. Hence we find the latter muscle occasionally (Phoca) encroaching upon the territory of these muscles and dwarfing them. The *infra-spinatus* and *teres minor* are sub-deltoid segments. But the *teres major* may rather be regarded as a *sub-latissimus dorsi* segment, forasmuch as it applies itself often to the under-surface of that muscle. At the same time it is more steadily connected than the *lat. d.* with the ulnar ridge of the humerus[2]. Both the *teres major* and the *supra-spinatus* sometimes (Pig) extend over the respective margins of the scapula upon the under-surface, and derive fibres which usually appertain to the *subscapularis*. The *teres major* does so more particularly; and its relation to this territory is also shewn by the fact that it and the hinder part of the *subscapularis* muscle are sometimes supplied by the same subscapular nerve.

The ilio-femoral mass forms the deep *gluteus* which is sometimes one muscle, but is often segmented into the *gluteus medius* and *minimus* and the *pyriformis*. The last is, in many instances, continuous with the *gluteus medius*. It commonly extends upon the under-surface of the ilium and upon the sacral vertebræ. It lies beneath the *gluteus max.* bearing, at the origin, a relation to it similar to that of the *teres major* to the *lat. d.*; and the gluteal vessels and nerves pass between its anterior edge and the ilium, just as the posterior branches of the subscapular vessels and nerves pass between the anterior edge of the *teres major* and the scapula[1].

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[1] This I think is the real explanation of that difference in the insertion of those corresponding muscles in the two limbs which has caused so much difficulty in determining their homological relations. The view is confirmed by the observation that the muscles arising from the dorsum of the scapula are not strictly tenacious of their connection with the radial tubercle; some of them at least in Birds and Lizards passing to the ulnar tubercle, or the ulnar edge of the humerus.

[2] In Scinc it passes to the ulnar side of the humerus, quite separate from the *lat. d.* In Manis it is very large, blended with the *lat. d.* at its origin, and accompanies it to the inner condyle of humerus, the olecranon and the forearm.

Thus the deep or girdle portion of the ventro-appendicular muscle in each limb divides itself more or less distinctly into sectors corresponding generally with, and often to some extent blended with, the sectors of the superficial stratum of the same muscle. The *coraco-humerals* in the fore limb, and the *adductors* in the hind limb, lie beneath, and are often respectively blended with, the *pectorals* and the *gracilis*. The *dorsalis scapulæ* presents similar relations to the *trapezio-deltoid*, and the *teres major* to the *latissimus dorsi;* and the same may be said, though less markedly, respecting the relations of the other corresponding muscles in the hind limb, viz., of the deep *glutei* with the *obliquus*, *sartorius*, and *tensor vaginæ femoris*, and of the *pyriformis* with the *gluteus maximus*.

THE FLEXORS AND EXTENSORS OF THE FOREARM AND LEG

are in each instance formed, *first*, by intrinsic muscles, that is, muscles arising from the humerus and femur; *secondly*, by extensions of the deep ventro-appendicular stratum, that is, by muscles arising from the girdle; and, *thirdly*, by extensions of the superficial ventro-appendicular stratum; and the muscles from these three sources are more or less blended. In the simple limbs of Fishes they form only one unbroken layer. Some amount of segmentation takes place in most other animals; but, owing to the simple nature of the movements they effect, the complications and varieties in these muscles are not very great or numerous.

The intrinsic flexors are represented by the *brachialis anticus*[2] in the fore limb, and by the short portion of the *biceps* —the *femoro-fibular*—in the hind limb. The latter is sometimes inserted low down in the leg (Cryptobranch and Cyclothurus)[1]. In other cases it meets and blends with the *biceps flexor cruris*, and is called the 'short' or 'femoral head of the biceps.' It is not unfrequently wanting. Both these are usually inserted into the post-axial bones of the limb—the ulna and fibula. The intrinsic dorsal or extensor muscles are represented by the parts of the *triceps* and of the *quadriceps* which arise from the humerus and the femur. They, in the fore limb, usually converge to the ulna and, in the hind limb, to the tibia.

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[1] See reasons, in *Journal of Anat.* v. 85, for regarding the *teres major* and the *pyriformis* to be serially homologous.

[2] In Hippopotamus the *brach. ant.* is wanting, the space on the outer side of the humerus from which it usually arises being occupied by the *sup. longus* which is large, and acts as simply a flexor. It might almost be described as *brach. ant.* inserted into the lower two-thirds of the radius instead of, as usual, into the ulna. The blending of the elements of these two into one is remarkable. The muscle winds round the back of the humerus to the inner side, and has a broad

The deep ventro-appendicular flexor—the flexor derived from the girdle—in the fore limb is the *biceps*, which presents variable degrees of continuity with, and segmentation from, the *brachialis anticus*, and which is further brought into continuity with the intrinsic series by means of muscular derivations from the humerus in the Bird, and not uncommonly, in other animals, including Man in whom they occur as a variety. These are generally from the ulnar side of the humerus; while the *brachialis anticus* extends chiefly from the radial side, between the deltoid and the triceps. The coracoid origin of the *biceps* and its relation to the coraco-humeral muscles have been already (p. 343) described. Those relations were found to be very close in Cryptobranch (p. 33), and they shew the *biceps* to be an intermediate between the *coraco-humerals* and the *brachialis anticus*, continuous with either or both, and uniting them into one group, which extends from the coracoid, along the ulnar and palmar surface of the humerus, to the radius and ulna[2]. When the coracoid reaches to the sternum the origin of the *biceps* is broad, expanding, fan-like, as it ascends; and sometimes

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origin beneath the inner tubercle. It thus dwarfs both of the humeral origins of the triceps. It is supplied by the radial nerve.

[1] *Journ. Anat.* VI. 22 and IV. 56.

[2] They are all usually supplied by one nerve—the musculo-cutaneous—which is the homologue of the coracoid nerve of Reptiles, and the serial homologue of the obturator nerve. The *brachialis anticus* is sometimes (Pteropus) found to be in direct continuity with the coraco-humeral. In Scinc the *biceps* derives two factors from the humerus, which occupy the position of the *brachialis anticus*. They are so named by Rüdinger, see p. 35, and *Journ. Anat.* II. 301, III. 303, IV. 37.

(Owl) it shews a tendency to divide into two—an outer, or glenoid, and an inner, or coracoid part. The division is complete in most Mammals; and the coracoid part forms the more superficial element of the muscle. Where the coracoid is very short, however (Manis), the division may disappear. The *biceps* is inserted into either or both of the bones of the forearm.

In the hind limb the flexor derived from the girdle, omitting for the present the consideration of the *biceps* to which I will revert, may, as in Cryptobranch, be blended, in its whole length, with the adductor mass; and it is often united with it to some extent. It however has rarely, or never, any connection with the femoro-fibular muscle (the short portion of the *biceps*). It is in most animals divided, in its whole length, into two. Of these the *semitendinosus* is usually the more free from the adductors[1], is the more superficial, is inserted lower down on the tibia, and is the representative of the coracoid part of the *biceps brachii*. The other—the *semimembranosus*—is the deeper, represents the glenoid part of the *biceps brachii*, and is more connected with the adductors, presenting every degree of cohesion to them. It has also, as have the adductors, varied relations with the *caudo-femoral* which sometimes (some Birds[2])—blends with it, sometimes (Cryptobranch) runs to the femur quite separate from it, and sometimes (Saurians) sends a long tendon, separate from the *semimembranosus*, down to the back of the fibular side of the tibia, or to the fibula, or to a sesamoid just above the fibula, from which the flexors of the foot and digits arise[3].

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[1] It retains a connection with the *gracilis* in Pteropus. In Seal the *semitendinosus* and *semimembranosus* remain one muscle, as their serial homologue the *biceps brachii* sometimes does in Mammals.

[2] In the Owl the *semimembranosus* and *adductor* are one muscle, which is joined by the *caudo-femoral*, and is partly continuous with the *gastrocnemius*. In the Swan the *caudo-femoral* joins the *adductor*, which is separate from the semimembranosus and is inserted into the linea aspera only. In the Gull the *caudo-femoral* is inserted into the femur unconnected with either the *semimembr.* or the *adductor*, which are separate; and the latter is partly continuous with the *gastrocnemius*.

[3] In the Dog the *semimembranosus*, arising from the tuber ischii, divides into two nearly equal portions. Of these one is inserted as usual into the tibia; and the other is inserted into the inner side of the lower part of the femur in the locality usually occupied by the *adductor magnus*. It is there blended with a tendon derived from the *add. longus*, and some fibres are inserted into the sesamoid of the inner head of the *gastrocnemius*. So that the sesamoid behind the internal condyle is a meeting-point between the *adductors* and the inner

The intrinsic extensors are represented by the parts of the *triceps extensor brachii* and the *quadriceps extensor cruris*, which arise from the humerus and femur, and which are very constant (except in Cryptobranch) and are subject to but little variety. The deep ventro-appendicular, or girdle, element is furnished by the scapular origin of the *triceps*, and by the *rectus femoris* or iliac origin of the *quadriceps*. Both these are connected with the dorsal surface of the girdles near the joints with the limbs; but the rotation of the fore limb usually directs the origin of the *triceps* to the hinder edge of the scapula, and the rotation of the hind limb directs the *rectus femoris* to the anterior edge of the ilium[1]. The superficial ventro-appendicular element is furnished in the fore limb by the *latissimus dorsi*, which in Cryptobranch is quite lost in the *triceps* and, in other animals, is partly blended with it; though, in Man and some Mammals, it passes to the humerus and has no connection with the *triceps*[2]. In the hind limb this element

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head of the *gastrocnemius;* just as the sesamoid behind the external condyle is a meeting-point in Lizards between the tendon of the *caudo-femoral* and the outer head of the *gastrocnemius.*

Some of the fibres of the tendon of the *adductor magnus* in ourselves are continued into the internal lateral ligament, and so reach the tibia. In Aï and Manis some fibres of the *semimembranosus* join the *add. m.* above the knee. In the Jerboa the two muscles are inseparably united, and are inserted by a continuous tendon into the femur, the tibia, and the side of the knee. In the Rabbit the *adductor* is inserted into the tibia, as well as into the femur. In the Hippopotamus the *semimembr.* continues in union with the adductor as far as the knee.

[1] In Bats the rotation of the hind limb is the reverse of what is usual; and in Pteropus I found the *rectus* arising from behind the acetabulum. *Journ. Anat.*, III. 312.

The *triceps* in Manis extends in conjunction with the *supinator longus*, upon the dorsum of the scapula and to the spine, lying over the *teres* and *supraspinatus:* and, in Batrachians and Reptiles, the *triceps* derives an origin, behind, from the coracoid, as, in the same animals, the *quadriceps* derives an origin in front from the pubes. In Scinc the long portion of the triceps divides, one part passing external to the *teres major* upon the dorsum of the scapula, and the other upon the under surface of the shoulder-joint and the coracoid.

In Phoca (*Journ. Anat.*, II. 302) a portion of the triceps (*dorsi-epitrochlien*), blended above with the scapular origin, and arising from the angle of the scapula, passes by the olecranon, along the ulnar side of the paddle, to the 5th digit. It forms a sort of intermediate between the *triceps*, the *teres major*, the *latissimus dorsi*, and the *costa alaris* of Birds, linking them all together and being linked by the two last to the ventral muscle.

For the parallel between the relations of the *triceps* to the radial nerve and those of the *biceps flexor cruris* to the peroneal nerve, see p. 53.

[2] The mode in which the *lat. d.* blends with the *triceps* in Cryptobranch explains its varied relations with that muscle—its passing in some instances on one side and in some on the other side of the scapular origin for instance—the fact being that its fibres are in some animals diffused in the *triceps;* in

is furnished by the *gluteus maximus*, which, in Birds, is blended with the quadriceps, and which, in Cryptobranch and other Batrachians, does not exist as an element distinct from the *rectus*[1]. In Mammals it partly expands into the *fascia* overlying the *quadriceps*, and partly is inserted into the fibular line of the femur. Sometimes it extends upon the outer side of the leg to the ankle and foot.

I have shewn (p. 22) that in Cryptobranch the long, or chief, portion of the *biceps flexor cruris* is a derivative from the *gluteo-rectus*, that is, from the blended, or unsegmented, superficial and deep ventro-appendicular extensions upon the dorsum of the limb; and that it inclines upon the lateral surface and plantar aspect of the limb, so as to acquire a flexor action. It often shews traces of this its origin. It retains its connection with the ilium in Lizards and Birds, being overlapped by the *gluteo-rectus* in the latter. In Mammals also it is often continued upon the ilium through the sacro-sciatic ligament. Not unfrequently it has more direct connection with that bone; and in some it extends, in close relation with the *gluteus*, upon the caudal vertebræ[2]. The inclination of this segment from the dorsal to the plantar aspect of the limb, and at the same time from an extensor to a flexor function, is probably due to the direction of the rotation of the limb. Accordingly, there is an absence of any distinct representative of it in Bats; and the nearest approach to the formation of a similar muscle in the fore limb is presented by the *dorsi-epitrochlien*—by such a one especially as we find in the Seal (see footnote, p. 354). It

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some they converge to and penetrate it at one point, in some at another; and in some they converge to, and pass on one side of it.

[1] In Birds there is no distinct *rectus femoris;* that is to say, this part of the quadriceps is not segmented from the *gluteus* or, as it might be called, *gluteo-rectus*. This is also the case in Urodelans (p. 22) and is paralleled by the imperfect segmentation of the *latissimus dorsi* from the scapular origin of the *triceps* in these animals (p. 36).

[2] In Orycteropus and Otter, the *biceps* arises from the ilium, ilio-sacral ligament and sacrum. In a wild Cat it was joined near the middle by a slip from the caudal vertebræ just behind the *gluteus*. In a tame Cat this slip, broad at its origin, was continued by a thin tendon which passed between the *vastus externus* and the *biceps* to the *fascia* on the outer side of the knee. In the Rabbit the chief origin of the biceps is from the sacral and caudal vertebræ; and it expands over the fibula and outer side of the leg, as far as the heel, without being inserted into the fibula. In Hippopotamus its disposition resembles that in the Rabbit; but it is more blended with the *gluteus* and has an insertion into the fibula. In Seal it reaches to and blends with the extensor tendons on the dorsum of the foot.

seems in many cases to be segmented from the *gluteus*, much in the same manner as the dorsi-epitrochlien is segmented from the *latissimus dorsi*.

Portions of the *triceps*, at the lower part of the arm, are not unfrequently segmented on one or both sides, constituting the *anconeus externus* and *internus*. A similar segmentation does not take place in the case of the *quadriceps*.

A sesamoid is very often developed in the lower end of the *quadriceps* and occasionally (Pteropus) in the lower end of the *triceps*. In the Wombat and a few other Marsupials the usual tibial sesamoid—the patella—is absent and a sesamoid—the fabella—is found upon the upper end of the fibula. We may connect this with the relation just described between the *biceps* and the *quadriceps*. The fabella can scarcely be regarded as the homologue of the patella, being connected with a different bone and a different part of the dorsal muscle. It presents more claim to be the serial homologue of the sesamoid in the *triceps*, situated above the olecranon which is the homologue of the large process growing from the upper part of the fibula in Monotremes. The connection of the fabella with an outlying portion only of the dorsal femoral muscle, whereas the supra-olecranon sesamoid is connected with the middle portion of the dorsal humeral muscle, is explained by the fact that the greater part of the femoral muscle is directed upon the tibia, whereas the greater part of the humeral muscle is directed upon the ulna.

The insertion of the *triceps* into the ulna while the *quadriceps* is inserted into the tibia has caused, in the mind of some anatomists, an unwillingness to admit the serial homological relation of the two muscles. The force of this objection, however, diminishes as we learn more of the manner in which the points of insertion as well as of the origin of muscles are liable to variation and to wander from one bone to another.

To sum up as thus far traced. The dorsal extension of the ventral muscle upon the hind limb gives rise to the *gluteus magnus*, the *tensor vaginæ femoris* and the *sartorius*, to the *rectus femoris* and the long part of the *biceps*, to the *pyriformis* and the *glutei*. The like extension upon the fore limb gives rise to the *latissimus dorsi* and the *trapezio-deltoid*, the long head of the *quadriceps* with the *dorsi-epitrochlien*, to the *teres major* and *minor* and the *infra-spinatus*. The plantar extension of the ventral muscle upon the hind limb gives rise to the *gracilis* and the adductors, including the *iliacus internus* on the one side and the *obturators*, *gemelli* and *quadratus femoris* on the other, together with the *semitendinosus* and *semimembranosus*.

The same upon the fore limb gives rise to the *pectorales* and the coraco-brachials, including the *supra-spinatus* on the one side and the *subscapularis* on the other, together with the *biceps.*

MIDDLE AND DISTAL SEGMENTS OF THE LIMBS.

The muscles on the ventral (palmar and plantar) and on the dorsal surfaces of these segments of the two limbs are, in each instance, as we learn from the lowest orders of Vertebrates (see Figs. 23, 24, 34 and 36 and Cryptobranch), in their primitive state, in one mass which is connected with, that is to say, is to some extent continuous with, the prolongations of the ventral muscle upon the limb. In animals above Fishes, in all of which a uniform plan of segmentation of the limbs is followed, each mass (palmar or plantar and dorsal) is usually attached to the bone of the upper segment of the limb and to the several bones of the middle and distal segments. In accordance with the feathering manner in which the limbs, especially in the lower animals, are pressed upon the ground and withdrawn from it, the fibres on the palmar and plantar surfaces are directed from without, inwards as well as downwards, take their origin chiefly from the post-axial (ulnar or fibular) condyle and the post-axial side of the limb, and constitute a 'pronato-flexor' mass in each limb; while the fibres on the dorsal aspect, having a supinato-extensor action, take a similar direction, passing downwards and inwards from the post-axial side of the limb, and in some instances, in the hind limb, from the dorsal part of the post-axial condyle of the femur. In the case of the fore limb, however, the ulna, rising into the olecranon, commonly shuts off the supinato-extensor mass of muscles from the post-axial condyle of the humerus, and causes it—the deep as well as the superficial layer of it—to spread upon the preaxial condyle and the preaxial edge of the humerus. A certain method of division of these masses into planes and sectors is common to them all, and is also common to them in most animals; though there are of course many varieties in detail. A part of either of the masses which associates itself with one plane or one sector in a certain limb or animal may be otherwise disposed in other cases; but the deviations are on the whole fewer and less than might have been anticipated. As a general rule each mass is divisible into a superficial and a deep stratum; and the superficial stratum is divisible into three sectors—two lateral and a median—though the division is by no means equally complete in all instances, that is to say, in some animals, as Cryptobranch, the segmentation is much less advanced than in others. It is usually less distinct in the pronator-flexor mass of the hind limb than in the several other masses. There is considerable variation in the extent to which the several masses are blended with the muscles of the upper segments of the limbs and with the extensions of the ventral muscles—the ventro-appendicular muscles—upon the limbs. The blending of the muscles of the upper segments is more observable on the palmar and plantar than on the dorsal aspects, because the dorsal projections of the elbow and knee commonly interrupt the continuity between the muscles above and below those joints.

PRONATO-FLEXOR MASSES.

The superficial stratum of these in Cryptobranch is very imperfectly segmented from the deep strata in both limbs; and in the hind limb it shows very little trace of division into sectors. In that limb it is a simple scarcely segmented mass extending from the fibular condyle and the fibular side of the limb upon the tarsus and digits. Superficially, it is continuous, through the medium of the *caudo-pedal*, with the superficial prolongation of the ventral muscle. This connection is in Lizards maintained only by a delicate tendon, and in higher animals does not exist; but the extensions of the *gluteus* and *biceps* are often substituted for it. The deeper (caudo-crural and caudo-femoral) prolongations of the ventral muscle are directed chiefly to the tibial side of the limb and do not commonly connect themselves with the pronato-flexor mass. Such a connection is however, as already mentioned, established in some Lizards by the descending tendon from the caudo-femoral running into the sesamoid above the fibula, from which the flexors of the foot and toes in part arise; and in some Birds there is a similar connection of the same muscle with the inner head of the *gastrocnemius* through the medium of the *semimembranosus*. In Manis the inner head of the *gastrocnemius* derives fibres from the *adductor magnus;* and we know that this muscle is sometimes intimately connected with the caudo-femoral in the animals in which the latter is present. Moreover, the *rectus internus* in Birds and Lizards is continued over the condyles of the femur into the fibular origin of the superficial flexor of the digits, affording a good illustration of the manner in which, from the primitive unstratified unsegmented homogeneous envelope of the limb-skeleton, special forms are evolved.

Continuing the investigation of this superficial stratum of the pronato-flexor mass in the hind limb, in the which, as just said, the caudo-pedal is blended, we find it in the lower animals where the foot is in a plane with the leg extending, for the most part, to the digits. As the heel grows out, however, the superficial pronato-flexor stratum becomes concentrated upon and more or less interrupted by it.

The *plantar fascia*, which represents the pedal part of the caudo-pedal, may thus become isolated—cut off by the projecting os calcis—from the crural fascia and from the superficial layers of the *tendo-Achillis* and *gastrocnemius*, which appear to represent the crural part of the caudo-pedal. The pedal part of the *flexor sublimis digitorum* may become, in like manner, cut off from the crural part, the former acquiring the name of *flexor brevis* and the latter that of *plantaris*. The rest of the stratum, uniting itself with the caudo-pedal and inserted into the os calcis, forms the *tendo-Achillis* with the *gastrocnemius* and *soleus*. The degree however of this calcareal interruption of the superficial pronato-flexor stratum varies. The *tendo-Achillis* is sometimes continued into the plantar fascia; and the continuity of the *flexor sublimis digitorum* from the femur to the digits, as well as its connection with the plantar fascia, is very frequent[1]. In ourselves the principle of concentration of force upon the heel is carried to the utmost. The pedal and crural parts of the stratum are quite isolated from one another by the os calcis; and additional power is brought to bear upon the heel by the origin of the *soleus* from the tibia and by the great development of the bellies of the *gastrocnemius.*

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[1] In Phoca (*Journ. Anat.* II. 314). The elements of the *flexor sublimis* are derived from the *plantaris*, the *gracilis*, the *flexor profundus* and the *tibialis posticus*. In Unau also it derives a factor from the *tibialis posticus*. These are interesting remnants of the primitive common basis from which the several muscles were segmented.

Thus considered, the *gastrocnemius* consists of the blended factors of the *caudo-pedal* and of the superficial layer of the pronato-flexor mass, some of which—the *soleus* elements—pass from the fibula, with occasionally factors from, or a connection with, the caudo-femoral. Most of these descend from the fibular side of the limb. In Amphibians the fibres that do so make up the whole muscle; and there is nothing to correspond with, or represent, the inner or tibial head of Birds and Mammals. This makes its appearance in Saurians as a thin muscular band descending from the lower edge and outer surface of the superficial plantar mass of the thigh—the part which represents the *gracilis* and *semitendinosus*—to the tibial side of the surface of the *gastrocnemius.* In Birds the tibial origin is connected rather with the portion which forms the *semimembranosus* or the *adductor;* and it acquires also a connection with tibial condyle of the femur. In Mammals the relation to the muscles descending from the thigh is lost, and the connection with the femur only remains, supplemented in Man by an origin from the tibia which constitutes the inner or tibial portion of the *soleus.*

The spreading of the *gastrocnemius* upon the fore part of the tibia in Birds, where it in some (Heron and Gull) is partially blended with the *sartorius*, is another illustration of the connection or continuity of the flexor with the extensor, or the plantar with the dorsal, muscles, and of the encroachment of one group upon the area of the other, of which we have seen so many instances. This portion of the muscle, though separated from the remainder by the *semitendinosus* passing between it and the internal condyloid head, is supplied by the popliteal nerve.

The blending of the *sartorius* with the *gastrocnemius* above mentioned is an interesting example of that continuity of the extensor and flexor muscles of the same limb, which is more remarkably exemplified, in a deeper stratum, by the continuity of the *internal rectus* with the *flexor digitorum.* Both subserve the same purpose, viz., that of assisting the action of the femoral flexors of the foot and toes during the condition of forced flexion of the knee which is so often and long maintained in Birds, and during which those flexors are much relaxed and less capable of acting upon the digits.

In the fore limb the superficial stratum of the pronato-flexor mass never acquires an origin from the radial condyle, such as would correspond with the tibial head of the gastrocnemius which we find in the hind limb of Birds and Mammals. The covering fascia, strengthened by prolongations from the *pectoral* and *biceps*, perhaps also from the *latissimus dorsi*, and sometimes strengthened by muscular fibres derived from the ulnar condyle which constitute the *palmaris longus*, is the representative of the caudo-pedal. The most distinct example of a prolongation of the ventral muscle upon the palmar aspect of the fore limb—the most distinct serial correspondent, in short, of the caudo-pedal—is, however, as stated p. 319, furnished by the *costo-alaris* of Birds[1].

Forasmuch as the carpus retains in all animals the flattened form, there is not here, as in the hind limb, a tendency to concentration upon a heel-bone thrown up in the middle, or an interruption of the several muscles by such a process. The components of this stratum are, therefore, more equally disposed upon the surface as they descend, than those of the hind limb; and they present a more distinct division into ulnar, radial and intermediate sectors. Of these the ulnar sector (*flexor carpi ulnaris*[2]), inserted into the cuneiform (with the pisiform) bone which is the homologue of the os calcis, is the chief representative of the *gastrocnemius* and *soleus*. In the intermediate sector, the *palmaris l.* expanding into the palmar fascia, where it blends with fibres of the *flexor carpi ulnaris*, represents the superficial part of the *gastrocnemius;* and the *flexor sublimis digitorum*[3] represents the *plantaris* and the *flexor brevis*

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[1] I have said that the *costo-alaris* is to some extent the serial representative of the *caudo-pedal*, and that the *palmaris l.* is also a like representative of the same muscle. An interesting exemplification of the relation of these parts is afforded in Phoca by the *palmaris l.* which, instead of arising as usual from the condyle of the humerus, passes upon the olecranon and blends with a portion of the *triceps* coming from the angle of the scapula, which again is in close connection with the *latissimus dorsi;* and it spreads like the *costo-alaris* upon the ulnar side of the carpus and hand. The similar exemplification in Manis afforded by the direct continuity of the *latissimus dorsi* with the palmar fascia and the *flexor subl. dig.* has already been pointed out.

[2] The *fl. c. u.* is not subject to much variety. It sometimes (Unau and Cyclothurus) spreads across the wrist superficially, meeting an expansion from the *supinator longus;* or (Phoca) it spreads beneath the *palmaris l.;* or it blends with the latter muscle or with the annular ligament. In the Proboscis Monkey it meets the *sup. l.;* and the expansion formed by them lies superficial to, and can be dissected off from, the fascia of the forearm.

[3] The *fl. d. s.* is partially interrupted at the carpus in Pteropus; and the *palmaris l.* in Aï. In Scinc the *fl. d. s.* is tendinous at the wrist and expands

digitorum which, as already shewn, are the upper and lower parts of the *fl. s. dig. pedis.* In the hind limb, the last-named muscle becomes, in higher animals, almost pushed out of the field, being reduced to the slender *plantaris* by the increasing gastrocnemius. But in the fore limb its homologue is in the ascendant and absorbs a great part of the fibres of the stratum at the expense of the *flexor carpi ulnaris* and also of the *palmaris l.*, which latter dwindles or disappears. The tibial sector of the superficial stratum in the hind limb shares the fate of the other parts of the stratum; indeed it is altogether absorbed by the heel muscle. In the fore limb the corresponding sector is large, is partly inserted along the radius, forming the *pronator radii teres*, and partly into the carpus or metacarpus, forming the *flexor carpi radialis.*

Thus, granting that the *plantaris* is represented by the *flexor digitorum sublimis*, the elements of the stratum which, in the hind limb, are made to converge into the *tendo-Achillis* are, in the fore limb, divided into the *palmaris longus*, the *flexor carpi ulnaris* and the *flexor carpi radialis* with part of the *pronator teres.* Moreover the *palmaris l.*, instead of being interrupted at the carpus, is continued into the palmar fascia; just as the homologous part of the stratum in the hind limb is continued into the plantar fascia in those animals in which the tarsus retains its primary simple, flat, carpus-like form.

I have before (p. 37, 38) pointed out evidences of the continuity of the upper (*pronator teres*)[1] part of the radial sector of the superficial stratum with the deepest (*pronator quadratus*) part of the deeper stratum; and the lower or *flexor carpi radialis* part of the sector is, in most animals above Urodelans, separate from the *pronator teres* and takes a deep course in the hand[2]. Now we find in the hind limb that the whole of the representatives of this sector—the representatives, that is, of the *pronator teres* and the flexor *carpi radialis*—or

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into a second muscle below the wrist; thus closely simulating the *plantaris* and *fl. d. s.* in the ordinary mammalian hind foot.

[1] The ulnar origin of the *pronator teres* in Man (also in the Chimpanzee and Rabbit) is an interesting remnant of this continuity. In the Bird (Kite) the muscle is in two distinct parts, both arising from the humerus. Some of the branches of the median nerve pass between, some above and some below, the two parts. The branches passing between them are distributed to the *fl. c. u.* and the *fl. dig. pr.* and represent, therefore, part of the ulnar nerve. See disposition of the muscle and its relation to nerves in the Cryptobranch, p. 37.

[2] In the Bird the *flexor carpi radialis*, like its serial homologue—the *tibialis posticus*—lies deep in its whole course. It arises from the ulna only and not from the humerus. See varieties of insertion into scaphoid and mets. I., II., and III. *Journ. Anat.*, IV. 42. In Phoca it is inserted into the scaphoid and Met. I. with a slip to Met. II.; in the Pig into Met. III.; in the Proboscis Monkey into Mets. II. and III.

such of them as are present, viz., the *popliteus* and the *tibialis posticus*, are situated in a deep level, nearly in the same level with the *pronator tibiæ quadratus* with which indeed the *popliteus* is sometimes merged. That is to say, the radial sector, though chiefly in a superficial level, is continued into a deep level through the medium of certain fibres of the *pronator teres* and through the tendon of the *flexor carpi radialis;* whereas the tibial sector, composed of the *popliteus* and the *tibialis posticus*, lies throughout in a deep level.

Indeed, the greatest and most essential features of difference with regard to this region in the two limbs is caused by the fact that the *flexor carpi radialis*, which in the hand lies in as deep a level as does the *tibialis posticus* in the foot and evidently corresponds with it, becomes in the forearm part of the superficial stratum and is attached to the condyle of the humerus; whereas the *tibialis posticus* continues its deep course in the leg and does not reach the femur at all. The plane of segmentation of the two muscles, which is the same in the hand and foot, differs in the forearm and leg. So that, although the two tendons might be regarded as serially homologous, the two muscles can scarcely be said to be so. Properly viewed, however, they furnish a good illustration of the way in which certain nearly corresponding muscles in the two limbs (and the remark applies to muscles of the same limb in various animals) are differently segmented from the parent mass. They afford further evidence that homological rule is not so rigidly followed in development as we may be disposed to think, and that we must not be too severe in our attempts to institute homological comparison.

The variation that occurs in the division of the strata and in the amount and disposition of the fibres attaching themselves to either stratum, is also shewn by the fact that in the lower animals the fibres of the radial and ulnar sectors are in great part inserted into the radius and ulna, so becoming flexors of the forearm upon the arm; and superficial prolongations only of them pass on to the carpus; whereas in higher animals the ulnar sector arising partly from the ulna is continued in its entirety to the carpus, and the radial sector divides into two parts, of which one—the *pronator teres*—is inserted into the radius, and the other—the *flexor carpi radialis*—is continued to the carpus.

The differences in the two limbs evidently have relation to the necessity that exists in higher animals for moving the foot forcibly as a whole for the purpose of driving the body onwards. This is accomplished by throwing the whole or the greater part of the strength of the superficial stratum of the pronato-flexor mass, including the elements of the caudo-pedal, upon the projecting lever furnished by the os calcis, and by applying a portion of the deeper stratum of the mass (*tibialis posticus*) to the same end as well as to the pronation of the limb; whereas in the fore limb the whole of the deep stratum, except the *pronator quadratus* and a considerable part of the superficial stratum, is available for the movements of the digits, and so subserves more directly to prehension and the requirements of the will. In the hind limb the muscular mass becomes absorbed by the elevator of the heel, and in the fore limb it becomes absorbed in the flexors of the digits.

Not only does the superficial flexor of the digits in the fore limb absorb nearly all the elements of the middle sector, and push the *palmaris l.* (the representative of the middle or superficial part of the gastrocnemius, including the caudo-pedal) nearly or quite out of the field; but it not unfrequently happens that it in turn gives place, in great measure, to the deep flexor. Thus it may be reduced (Hatteria), much like its homologue in the hind limb of Man, to a mere thin muscle, arising near the wrist from a ligament extended between the *os pisiforme* and the *os naviculare,* or (Unau) it may be a mere slip from the deep flexor, or it may (Phoca) be imperfectly segmented from the *palmaris*[1].

As a prelude to further analysing and reducing the pronato-flexor masses and entering upon the consideration of their deeper strata, we must remember the numerous skeletal moveable parts in the distal region of each limb, and must conceive an unsegmented chaotic muscular mass passing from above downwards, and dropping fibres upon and deriving fibres from the several skeletal parts after the manner which is suggested by the anatomy of the limbs in Fishes and in Cryptobranch.

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[1] In Carnivora, where it is usually small and often imperfectly segmented from the *palmaris*, the superficial fibres of its tendons commonly blend with the palmar fascia and pass into the pads and the skin; and the deeper fibres form the perforated tendons to the phalanges. In the hind limbs of a Dog and of a Cat some of these fibres to the pad were derived from the *fl. prof.* and passed between the tendons of the *fl. subl.* Delicate muscular slips also passed from the deep to the superficial flexor tendons in the sole of these animals.

In Jerboa the *flex. subl.* passes to the three middle digits only; the other digits (I and V) receiving delicate muscular superficial flexors from the supernumerary carpal ossicle which is present in that animal. These, like the same muscular Hatteria, remind us of the usual disposition of the *fl. subl.* in the hind limb. In Guinea Pig the superficial flexor sends the greater part of its tendon to join the *fl. prof.* The superficial flexor to digit V. is formed on the radial side by a tendon from *fl. prof.* and on the ulnar side by a small muscle arising from the palmar fascia. In short, the varieties in the segmentation of these muscles are very numerous.

In the Heron and some other birds, the *fl. d. s.* is little more than a tendon passing, from the int. condyle and the cuneiform bone, to the fascia and the proximal phalanx (it passes to the second phalanx in the Swan). In the Jackdaw it is a muscular slip from the *flexor carpi ulnaris.* In the Rook it is a separate small muscle arising by a tendon from the int. condyle and passing partly into the *fl. c. u.* and partly to the proximal phalanx of the digit. See varieties in disposition and relations between the deep and superficial strata, *Journ. Anat.* IV. 43. In Manis the superficial flexor passes to the pollex and is continuous above with the *latissimus dorsi.*

In the Cryptobranch, segmentation has gone to a certain extent. Take the hind limb. *First,* the superficial fibres pass the farthest, extending from the femur, indeed from the tail, to the terminal phalanges, and they form a superficial stratum; still this stratum is very imperfectly separated from the deeper portion of the mass. *Secondly* (Figs. 9 and 11), a band is segmented from the deep part of the mass and is directed upon the bases of the digits, forming a *flexor profundus digitorum*. *Thirdly* (Fig. 12), several small deep bundles are segmented, passing from one skeletal part to another near by, so constituting 'intrinsic' muscles—*tarsometatarsales, metatarso-phalangei, phalangei* and *intermetatarsales* or *interossei*. The residuum of the mass constitutes what I have called the *pronator pedis* (Fig. 10). And there is a similar arrangement in the fore limb.

In higher animals the proximal skeletal parts move less upon one another; and the *flexor profundus* grows at the expense of the other components of the deep stratum first mentioned, the germs of which are either absorbed or dwarfed by it, except those of the *interossei*. The *pronator pedis* also in part blends with it, the tarsal portion of its origin forming the *accessorius*[1], and the fibular portion of it forming the *flexor hallucis*. This last joins the deeper surface of the *flexor profundus,* and may be destined, as its name implies, chiefly to the hallux; or it may form part, and even the greater part, of the tendons to the other toes[1].

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[1] In Proboscis Monkey the *accessorius* is united with the tibial flexor (*flexor prof.*) only.

The union of the two strata is sometimes (Unau) retained by the blending of the *accessorius* with the *soleus*, and also by a slip in the same animal from the *tibialis posticus* to the *flexor sublimis*. In Orycteropus also the *tib. post.* sends a slip to the *plantar fascia;* and in Unau it sends a slip to the superficial flexor tendon of digit IV.

In Phoca the *tibialis posticus* retains its connection with the elements of the short flexor muscles of digit I.

I have already (footnote on p. 364) mentioned slips from the deep to the superficial flexor of the digits; and, in Phoca, Otter and Racoon, slips pass from the *accessorius* to the superficial flexor tendons or to the *plantaris fascia*.

In the Rabbit the *tibialis posticus* curls over the inner side of the scaphoid bone and terminates in the extensor tendon of digit II., thus contrasting with the termination of the *tibialis anticus* in the *flexor digitorum* which we have marked in Unau, *Journ. Anat.* IV. 66.

The elements of the *pronator manûs* become disposed of in much the same way as those of the *pronator pedis;* but they rarely contribute an '*accessorius*[2]' origin from the carpus, corresponding with the *accessorius* muscle in the foot. They become, however, more closely blended with the *flexor profundus digitorum* above, than do their homologues in the leg; that is to say, the ulnar origin of the *fl. dig.* does not retain its individuality so much as does the fibular origin in the hind limb; and when a *flexor longus pollicis* is segmented it is so from the radial side[3].

In this arrangement of the parts in the fore limb of higher animals we note more deviation than in the hind limb from the primitive simple condition. In the hind limb the pronato-flexor fibres chiefly take an oblique direction, from the fibular side downwards and inwards, and combine the movement of pronation with that of flexion. In the construction of the fore limb provision is made that each of those movements should take place in a greater range and each more independently of the other than the hind limb. For this purpose the muscular fibres are arranged into two more distinct sets, a pronator set passing to the radius and a flexor set passing to the digits; and the latter take a more vertical course; indeed, they scarcely shew any indication of crossing from the ulnar towards the radial side.

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[1] It is not an uncommon arrangement, in Monkeys especially, for the tibial flexor to pass chiefly to digits III. and IV., the fibular flexor passing chiefly to the other digits; and the *lumbricales* then commonly arise from both. In Proboscis Monkey the *fl. tib.* passes to digits II. and V., and the *fibularis* to I., III., and IV.; and, which is very unusual, the two muscles are not blended in any part of their course but are quite distinct.

[2] In some Saurians (Scinc) a muscle arises from the cuneiform bone and passes to the deeper surface of the tendon of *fl. d. s.*, representing the *accessorius.*

[3] In the wild Cat the *fl. prof.* is large, dwarfs the *fl. sublimis* and derives origin from the internal condyle, the ulna and the radius; and each of the tendons, traced upwards, acquires fibres from the several origins, the tendon to the pollex acquiring as many fibres from the condyloid and ulnar as from the radial origin. In the Dog the radial portion passes chiefly into the tendon to the pollex, the ulnar portion chiefly into the tendon to digit V., and the condyloid portion chiefly into the other three tendons. It is seldom, however, that the radial portion to the pollex is so completely segmented as in Man.

Such varieties are very significant with reference to the mode of development and the homological relations of muscles. They shew great diversity in the arrangement and blending of corresponding embryological germs without any obvious purpose, a tendency to variety within the range permitted by the high controlling forces which ensure the requisite subservience to utility.

The deepest part of the *pronator manûs* mass becomes the *pronator quadratus* which, below, may (Scinc) extend upon the carpus and, above, may reach and blend with the *pronator teres.*

The elements of the tarso-metatarsals (or carpo-metacarpals), the metatarso- (or metacarpo-) phalangeals and the phalangeals follow those of the pronator pedis (or manûs) in uniting with, or retaining their union with, the *flexor profundus.* Advancing forwards, however, they often separate from it, and, attaching themselves to the sides of the phalanges, form the *lumbricales* from their lateral parts and the *retinacula* from their middle parts. The phalangeals are probably included in the latter, but occasionally remain separate and often disappear. Hence the *lumbricales* are commonly found chiefly upon the deep surface of the angles between the tendons of *flex prof.*, and are often nearly or quite continuous with the *accessorius.* In the cases of the lateral digits, I. and V., their elements remain in part or wholly upon the metatarsals and form the short flexors. For this reason the *lumbricales* are not usually present on the tendons to these digits, or one only is present, lying upon the tibial (or radial) side of the tendon to digit V. More rarely there is one on the fibular (or ulnar) side of the tendon to digit I[1].

To put it in another way, the *lumbricales* and *retinacula* may be regarded as parts of the common flexor mass, which, instead of becoming segmented into metatarso-phalangeals and phalangeals, retain their connection with the flexor tendons and are separated with them from the tarsus and metatarsus; but they are not detached from the phalanges to which they accordingly pass from the flexor tendons. Their connection with the extensor tendons in Man and some Mammals is a reminder of the blending of antagonistic muscles into a common sheath which we have found, as illustrated by Lepidosiren, to be one of the features of the primitive limb[1].

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[1] In some animals (Scinc) the *lumbricales* pass from both sides of the several tendons of the *fl. prof.* to both sides of the digits. In the foot of Pteropus there are eight *lumbricales*—one on the fibular side of the hallux, one on the tibial side of digit V., and one on each side of each of the other digits. Usually, in Mammals, they arise only from the approximated sides of the tendons (or, as commonly described, from the clefts between the tendons); and the fibres, instead of following the two sides of the several tendons and forming eight muscles as in Pteropus, are combined into four (the two in each cleft fusing into one) which pass to the tibial (or radial) side of the four outer digits.

Not only does the *flexor profundus* thus absorb or retain annexed to it these various elements of the deep stratum of the pronato-flexor mass; it also, in most animals above the Salamanders, retains its connection with the terminal middle portion of each digital division of the superficial stratum, or superficial flexor, so passing on to the terminal phalanx; while the lateral portions of the superficial flexor tendons, disconnecting themselves from the middle terminal portion, stop at a preceding phalanx. In this way the deep flexor comes to perforate the superficial flexor, which splits, allowing it to pass[2].

Here I may observe that the ordinary mode of disposition of tendons passing along the digits is that each tendon approaching a joint divides into three. Of these the lateral parts are attached to the phalanx immediately on the distal side of the joint; and the middle part runs onwards to the next joint, where a similar process is repeated. This is best seen in the digits of Birds and Reptiles where there are more than two phalanges, and is well illustrated in the Plate of the Whale's fin by Prof. Struthers (*Journal Anat.* VI. Pl. VII.). It is seen also, according to the view just given, to be exemplified in the usual arrangement of the tendons of the superficial and deep flexors of the digits; these being regarded, as they may be in each digit, to be segments of one flexor prolongation upon the digit. This flexor prolongation first detaches from its sides the *lumbricales* to the first phalanx, runs on, and in like manner detaches the slips of the *flexor sublimis* to the second phalanx, repeating the same process according to the number of phalanges, and finally reaches the terminal phalanx.

THE SUPINATO-EXTENSOR MASSES.

The division of the superficial stratum of this mass, in each limb, into three sectors is more generally found to be distinct

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[1] In Pteropus (*Journ. Anat.* III. 306) the *lumbricales* lie in their whole length along the tendons of the *fl. prof.*; and one of these tendons is, for a space, interrupted by muscular fibres.

[2] This continuation of parts of the deep flexor stratum into a superficial region is of like kind to that which has been just mentioned in the instance of the *flexor carpi radialis* passing from a deep level at the wrist to a superficial level in the forearm.

than in the pronato-flexor masses. In some of the lower animals the three sectors arise from the humerus, or the femur, and are inserted by their deeper fibres into the bones of the middle segment of the limb; while their superficial fibres pass on to the distal segments. Owing, however, as before mentioned, to the convexity of the elbow and knee-joints in this direction, they are more cut off from continuity with the muscles above than are the antagonistic pronato-flexor masses. Indeed, in the hind limb, the connection of the supinato-extensor muscles with the femur is commonly reduced to a single tendon. In ourselves it is lost altogether, and the fibres are all directed from the leg-bones downwards, instead of passing, in part, from the femur to the leg-bones.

Traced downwards the middle sector of the supinato-extensor mass varies but little in either limb. It commouly extends upon the digits, forming the *extensor digitorum sublimis* (*communis*), and sometimes reaches to the terminal phalanges. Not unfrequently it does not pass upon digit I. Sometimes it fails to reach digit V.; and in some instances (Aï, Lizards, and Menobranch) it extends no farther than the metatarsus or metacarpus.

The inner—tibial or radial—sector is, in Batrachians, partly inserted into the tibia or radius, and partly runs on to the inner side of the distal segment. In the fore limb it sometimes (Saurians) reaches no farther than the lower end of the radius. Commonly, in Mammals, a segment only of it is inserted into the inner edge of the radius, constituting the *supinator radii longus*, which may extend to the inner edge of the pollex, or may spread upon the palmar surface of the forearm[1]. Other segments, passing close to the carpus and inserted into the metacarpals, constitute the *extensores carpi radiales* (*longior* and *brevior*)[2]. These divisions do not take place in Birds, where the entire sector is continued to the carpus; neither do they take place in the corresponding sector (*tibialis anticus*[1]), in the hind limb of Mammals and Birds.

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[1] This muscle is often so disposed as to afford an example of a muscle belonging to the extensor group acquiring, from its position, a flexor action. It is absent in the Rat, Rabbit, Hedgehog, Mole, some Ruminants and others. In Hippopotamus, as already said (footnote on p. 351), it is very large, its origin extending high on the humerus, in the space, external to the deltoid, which is usually occupied by the *brachialis anticus*; and it acts as a flexor of the forearm.

[2] Where there is only one of these it commonly passes to Met. III. (*Journ. Anat.* IV. 45). The second tendon is inserted into Met. II. The insertion of these radial carpal extensors may reach to Mets. IV. and V. (*Journ. Anat.* III.

The outer or fibular and ulnar sector—the *peronei* and *extensor carpi ulnaris*—usually pass over the ankle or wrist, and each is inserted into the outer side of the metatarsus or metacarpus. They often detach, in each limb, tendons to the *ext. dig.*, which cross beneath the tendons of that muscle, and run along their outer sides to the terminal phalanges. Sometimes they appear to form a group intermediate between the *ext. sublimis* and the *ext. profundus digitorum*[2]. In the foot a further division not unfrequently takes place. One of the segments

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308). In Phoca it is inserted into Mets. I. and II.; this variation having relation to the large size of the pollex in that animal.

[1] In a Dog, however, I found a slip given off from the fibular side of the *tib. ant.* joining a slip from the *ext. prof.* (*brevis*) *dig.* and inserted into Met. II. There was also another slip from the *ext. prof.* inserted into Met. III. In the Pig the *tibialis ant.* is very small; and the *ext. dig.* sends tendons to Mets. II. and III. and to the int. cuneiform as well as upon the digits.

In the Hippopotamus the arrangement is peculiar. The *tib. ant.* has extensive origin from the upper end of the tibia, the capsule of the joint and the patella, nearly encircling the *ext. dig.*, to which it sends a slip. It is inserted into the inner side of the internal cuneiform bone and into Met. II. The *ext. dig. sublimis* (*longus*) arises by a strong tendon from the fore part of the ext. condyle and, after appearing from beneath the superficial part of the *tib. ant.*, divides into a superficial and a deep portion. The former, passing in front of the annular ligament, expands into the tough tissue beneath the skin of the dorsum of the tarsus, and acquires an attachment to the bones on both sides of the tarsus. The deeper portion, passing under the annular ligament, divides into two tendons: one, connected closely with the preceding in the leg, is inserted into the cuneiform bones and Mets. II. and III.; the other divides into four tendons to the terminal phalanges of the four toes. The portions of this muscle which are inserted into the tarsus and metatarsus, passing both above and beneath the annular ligament, are described by Gratiolet as appertaining to the *tibialis ant.;* but they arise from the femoral condyle with the *ext. dig.* The *peroneus brevis* is not inserted into the metatarsus, but divides into two tendons which join the fibular side of the tendons of the *ext. subl.* to digits IV. and V. The deep layer in Hippopotamus consists of an *ext. hallucis*, arising from the fibula, perforating the tarsal insertion of *ext. dig. subl.*, and lost upon the second phalanx of dig. II. (there are three phalanges to this digit): also of an *ext. profundus* (*brevis*) arising from the os calcis and dividing to the four digits. Thus, digit II. has three extensors,—*ext. subl.*, *ext. prof.*, and *ext. hallucis*,—a combination, that is, of the extensors which are usually distributed to digits I. and II.

The *extensor digitorum* in the fore limb sends off a slip corresponding with the superficial part of *ext. dig. pedis;* but it is lost in the tissue beneath the annular ligament instead of passing over it. There is no deep (short) extensor of the digits.

The *extensor carpi radialis* presents a striking resemblance to the metatarsal division of the deep portion of *ext. dig. subl.* of the foot above described. It is large, connected on the one side with the *ext. dig.* and on the other with the *sup. r. l.* It is inserted by a broad tendon into the bases of Mets. III. and IV.

See description of *extensor secundus* and *supinator manûs* in footnote on p. 373.

[2] I have described this group as *extensor secundus digitorum. Journ. Anat.*, II. 307.

(the *peroneus tertius*) runs to the dorsal surface of the metatarsus and sends offsets to the *extensor digitorum*, which form the *ext. secundus* group just referred to[1]; while two segments run, one (*peroneus brevis*) behind the malleolus to the outer or fibular side of the tarsus, and the other (*peroneus longus*) is prolonged over the fibular edge of the tarsus, beneath its plantar surface, to the metatarsals, often as far as that of the hallux. The two last-mentioned segments thus acquire a flexor action. The course of the *peroneus longus* from the extensor aspect, over the fibular edge, upon the plantar aspect, to the inner side of the foot is paralleled (as suggested, p. 348) by that of the *internal rectus* of Birds and Saurians[2]. Nothing distinctly answering to this plantar extension of the *peroneus longus* is found in the fore limb. In it the whole of the sector passes upon the dorsal aspect, or the ulnar edge of the carpus or the metacarpus. It does, however, sometimes incline to the palmar aspect[3].

The *abductor minimi digiti* is segmented from the lower end of this sector and constitutes a continuation of it upon the ulnar, or the fibular, side of the distal part of the limb; and, in like manner, the *abductor pollicis* or *hallucis* is a continuation, more or less distinctly segmented, of the radial or the tibial sector upon the pollex or the hallux.

The foregoing observations shew that each of the three sectors of the superficial sheet of the supinato-extensor mass, in either limb, may be imperfectly segmented from the others, and that each may extend upon the digits, or may be, partly or wholly, arrested at a more proximal point of the distal segment of the limb.

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[1] The *extensor secundus* is formed by the *peroneus brevis* in Hippopotamus.

[2] In Birds the *peroneus l.* takes a more superficial course. Its origin extends over the *tibialis anticus*, meeting the tibial origin of the *gastrocnemius*; and its tendon forms part of the *flexor sublimis digitorum*, and also joins the sesamoid body through which the tendons of *fl. dig.* pass. In some animals it takes origin from the femur as well as from the fibula.

[3] In Birds the ulnar segment of the *extensor carpi ulnaris*, arising from the back of the ulna and supplied by the radial nerve, is inserted into the metacarpal (IV.) and is so placed as to exert a distantly flexor action, thus resembling the *peroneus brevis*. This is very decided in the Swan and the Kite. In the Hippopotamus the *ext. c. u.*, which is composed chiefly of tendon or fascia with a few muscular fibres, approaches the palmar aspect of the ulnar side of the forearm, and is inserted into the large pisiform bone, with the *flexor carpi ulnaris*, so as to combine with it in flexing the carpus.

See divisions of *ext. c. u.* resembling those of *peroneus*. *Journ. Anat.* IV. 45.

The deep strata of the supinato-extensor masses correspond generally with those of the pronato-flexor masses. They pass from the fibula and the tarsus, or the ulna and the carpus (in the fore limb from the humerus also), inwards and downwards, to the tibial or the radial side of the foot or the hand, and to the digits. They are frequently in some degree blended, above and below, with the several sectors of the superficial stratum.

In the hind limb the most persistent part of the stratum is the lowest part—the *extensor brevis*, or rather *profundus digitorum*—which may arise from the tarsus, or the fibula, or both. Its tendons blend with those of the *extensor sublimis*, passing to their under-surface and margins, or frequently to their outer margins only. When (Aï and Lizards) the *ext. subl.* does not extend upon the digits, the *ext. pr.* takes its place, constituting the chief or sole extensor of the digits. It is in the digits sometimes blended with the *interossei*. It is, not unfrequently, united with the peroneal tendons which passing upon the digits form the *ext. secundus;* or the peroneal sector may supply digit v. to the exclusion of the *ext. prof.*; or that digit may be omitted by both. In Cryptobranch (p. 29, Fig. 15), a small portion of this deep stratum, a small muscle, that is, passing from the fibula, continuous with the *extensor profundus* and inserted into the tibial side of the metatarsus, is a *supinator pedis*, which corresponds with the *supinator manûs.*

In Unau and Aï this portion extends higher and forms part of the *tibialis anticus*[1]. In most Mammals this highest part of the deep supinato-extensor stratum is not implanted with the *tibialis ant.* into the tarsus. It does not, therefore, form a *supinator pedis*, but it runs on to the hallux, forming the *extensor hallucis*, and standing in the place of a division of the *extensor digitorum sublimis.* Thus the hallux derives two tendons from the deep stratum, one from the *ext. dig. prof.*, and one from a higher part of the stratum; instead of, as in the case of the adjacent digits, having one tendon from each stratum.

In the fore limb the disposition is often, in some respects, different. The upper part of the stratum commonly preponderates over the lower, and often extends up to the outer condyle of the humerus. Passing from this point upon the upper part of the radius it constitutes the *supinator radii brevis*[1]. Lower down, passing from the ulna to the radial edge of the carpus or metacarpus, it forms (Cryptobranch, Fig. 17) the *supinator manûs*, commonly called *ext. ossis met. pollicis*. Lower still, as in the hind limb, it passes in one or two portions upon the pollex, which take the place of a division of the *ext. digit. subl.* Still lower, it may send tendons to digit II. and perhaps to other digits, so forming an *extensor profundus*[2]. These tendons join the outer or ulnar sides of the tendons of the *ext. subl.* Towards the ulnar side of the hand these tendons are usually absent; and their place is sometimes supplied by offsets from the ulnar sector of the superficial stratum above-described, forming an *extensor secundus;* in the same way that the tendons of the *ext. profundus* in the hind limb are sometimes supplanted by offsets (*extensor secundus*) from the peroneal sector[3].

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[1] *Journ. Anat.*, IV. 66. A lower segmented portion in these animals runs from the extremity of the fibula to the internal cuneiform bone. The still lower segment, arising from the tarsus, forms the *ext. dig. prof.*

It is evident, in short, that the muscles in the fore limbs of Mammals, which we are in the habit of designating *extensores pollicis, indicis*, &c., are really elements of the *extensor profundus;* and they correspond with the *extensor profundus* of the foot, but take their origin from a higher point of the

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[1] This is absent in Rabbit, Pig and some others. It has a sesamoid bone near its origin in Manis.

[2] In Hätteria the muscle is described by Dr Günther (*Phil. Trans.*, 1867, p. 614) as composed of fibres "arising from the distal half of the ulna and spreading over the bones of the carpus to which they are attached: the fibres nearest the radial margin are collected into a tendon which is inserted into the metacarpal bone of the thumb." It is covered by an *extensor communis dig.;* and an extension of it to the phalanges of the digits would have constituted an *extensor profundus* (*brevis*) *dig.* corresponding nearly with the ordinary *ext. pr.* (*br.*) *dig. pedis.*

[3] In the Hippopotamus an *extensor secundus* in the fore limb arises from the ulna and passes to the ulnar sides of the terminal phalanges of digits IV. and V., joining the sides of the tendons of the *ext. subl.* and precisely corresponding with the distribution of the *peroneus brevis* in that animal.

The deep stratum in the Hippopotamus is concentrated into one muscle, the *supinator manûs* (*ext. poll.*) which is small, arises from the ulna, and passes between the *ext. dig.* and the *ext. c. r.*, then, over the latter, to the rudimentary trapezium into which it is inserted. In appearance and position, in its upper part, it resembles what I have described in this animal (footnote, p. 370) as the *ext. hallucis;* but its insertion is different, and it passes over, instead of perforating, the *ext. c. r.* It corresponds precisely with the *supinator pedis* of the Cryptobranch above mentioned.

limb. The uppermost of the group—the *extensor ossis metarcarpi pollicis*—being inserted into the radial side of the carpus, and sometimes of the metacarpus, is better designated *supinator manûs* or *carpi*. It, in conjunction with the true *extensores pollicis* on the one side, and the *extensores carpi radiales* with the *supinatores radii* on the other, constitute the radial sectors, deep and superficial, of the supinato-extensor mass; and they correspond with the tibial sectors of the same mass in the hind limb which is resolved, in different animals, into *extensores hallucis, supinator pedis* or *tarsi* and *tibialis anticus*. The chief difference consists in the freer segmentation of the mass in the fore limb, in accordance with the freer movements of the several parts. Thus in Mammals the *extensores carpi radiales*, the *supinatores radii*, and the *supinator manûs* have their homologous elements, so far as they are developed in the hind limb, all blended in the *tibialis anticus*, from which the *extensor hallucis* is, in some instances, barely segmented. Another difference in the disposition of the stratum in the two limbs of most Mammals consists in the attachment of the fibres of a considerable part of the stratum in the hind limb to the tarsus—the origin, that is, of the *ext. prof.* from the os calcis. A similar disposition is, however, met with in the fore limbs of many Reptiles and in some Mammals[1].

Usually (though not in so primitive a form as that of the Cryptobranch, p. 41) the elements of the deep extensor stratum, like the elements of the deep flexor stratum, are continued upon the phalanges farther than those of the superficial stratum. Thus, as already seen, the superficial extensor in Menobranch, Lizards and Aï stops at the metacarpus. In the Bird's wing it is inserted into the first phalanges[2]. In Mammals the greater part of it is inserted into the second phalanges; whereas the elements of the deep stratum arising from the carpus or tarsus, and the radius and ulna, or the tibia and fibula, as well as the elements of the still deeper—the interosseal—stratum, are continued to the distal phalanges.

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[1] *Journal of Anatomy*, IV. 47.

[2] In Birds there are commonly only two rows of phalanges in the wing. In the Swan, where there are three rows, the superficial extensor is still inserted into the first row; and the deep extensor, which arises by two portions (a superficial and a deep) from the radius, is chiefly inserted into the second row and sends on a delicate slip to the third. This is the case also with the *interossei*.

In the Bird's foot, on the contrary, the superficial extensor reaches the terminal phalanges; the deep extensor, when present, joins, as in Cryptobranch, the deep surface of the superficial extensor; and the *interossei* are inserted into the proximal phalanges.

When factors of the *superficial extensor* are continued onwards with prolongations of the deep stratum to the terminal phalanges, they are usually derived from the marginal parts of its digital tendons, the middle part of each tendon being inserted into the more proximal phalanx. Also when the tendons of the superficial extensor reach to the terminal phalanges, without such prolongations of the deep stratum, it is still their marginal parts that do so. Thus in the lateral or fibular digit of the Swan's foot the extensor tendon passes over the first phalanx without being attached to it. It then divides into three; of which the middle is inserted into the second phalanx, and the two lateral components pass onwards. The tendon resulting from their union is, in like manner, again subdivided; the middle portion being inserted into the third phalanx, and the two lateral portions running onwards and meeting to be inserted into the fourth phalanx.

This disposition is the reverse of that of the antagonistic tendons on the flexor aspect. In their case (as mentioned at p. 368), the deeper and more prolonged tendon occupies the middle position, and continues its course in that position onwards to the terminal phalanx, while the superficial tendon is inserted into one, or commonly both margins of a more proximal phalanx. Also when the superficial and deep flexor are fused into one, and that one subdivides to supply the several phalanges, it is usually the middle part which is the more prolonged; and it never receives any marginal additions from the deeper strata.

The *interossei* in the simple limbs of some of the lower animals, as Cryptobranch, are mere bands passing across between the metacarpals or metatarsals, drawing the digits together and antagonising the abductors of the marginal digits. In higher animals, where the metacarpals and metatarsals admit of very little movement to and from one another, the tranverse direction of the interossei is changed for a course more parallel with the digits; and they extend upon the phalanges and, in many instances, blend with the extensor tendons. Their proper complement, when thus arranged, is one on each side of each digit; and their action, as flexors, extensors, adductors or abductors, depends upon the part of the phalanges or their tendons to which they are attached. The resultant of their combined action, especially in the simple transverse mode of disposition, is to approximate the other digits to the middle one. Practically, however, they are usually so arranged and co-ordinated that they effect lateral inclination of the phalanges in both directions. Those which incline the other digits towards the middle one are commonly situated near to the plantar or the palmar aspect, and are associated in action with the flexor muscles of the digits, even though they may be blended with the extensor tendons; and those which incline the digits from the middle one are situated nearer to the dorsal aspect, and are associated in their action with the extensor muscles. In many animals the lateral inclination of the phalanges is very slight, being limited to slight separation of the digits in extension and approximation during flexion. The *interossei* in them grow towards the palmar or plantar aspect, appear all to be associated with the flexors of the digits, and are sometimes aided by an additional, or second, series developed beneath, i.e. superficial to, them[1].

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[1] The *interossei* in the hind limb of the Hippopotamus are one on the plantar surface to each side of each digit. They arise from the heads of the metatarsals and the sheath of the *peroneus l.*, and pass to the sides of the sesamoid bodies and the sides of the first phalanges. In addition to these eight are two, larger and more superficial than the others, arising from the sheath of the *peroneus*, and passing to the apposed sides of digits II. and V., adducting those two to each other strongly. There are no dorsal *interossei*.

In the fore limb the arrangement is the same: viz. the eight small muscles lying close upon the metacarpals and the two larger muscles, adductors of digits II. and V., arising from the middle of the carpus. There are, besides, two abductors of II. and V., the one arising from the scaphoid and the other from the pisiform bone. These are barely represented in the hind limb by small muscles passing from the cuboid and the internal cuneiform bones.

The two adductors in both limbs resemble the palmar *interossei* of Man.

There is in each limb only one *lumbricalis*. It arises from the superficial surface of the *flexor profundus* before the division to the digits, and runs to the preaxial side of the fourth digit.

ON THE STERNUM OF THE SPERM WHALE (PHYSETER MACROCEPHALUS). By PROFESSOR TURNER.

THE sternum of the Sperm Whale has been described by Beale[1] from the skeleton of the whale stranded at Holderness in 1825, and preserved at Burton Constable, near Hull: and it has been described and figured by Wall[2] from specimens in the Sydney Museum, and by Flower[3] from a specimen stranded near Thurso in 1863, now in the British Museum, and from a specimen from Tasmania, in the Museum of the College of Surgeons, London. In all these specimens the ossification of the bone was incomplete, so that not only its subdivision into transverse segments, but its separation into two lateral halves was marked either by strong sutures, or by fissures extending through its entire thickness.

In the month of July, 1871, a large sperm whale was stranded in Loch Scavaig, Isle of Skye. Several of its bones are now in my possession, and from the completed ossification and dimensions of the bones, there can be no doubt but that the animal had attained its full growth, and in all probability was of the male sex[4]. A general estimate of the size of the animal may be obtained from the dimensions of the mandible, which was 190½ inches in length, by 56 inches in greatest girth.

Amongst these bones is the sternum, and as it presents a more fully ossified condition than has previously been observed, I propose to give a brief description of the bone.

The sternum is a massive plate-like, triangular-shaped bone, greatly expanded anteriorly in its transverse diameter, and gradually tapering backwards to the posterior end, which forms the rounded apex of the triangle. The inferior surface is convex, the superior concave. The anterior border is convex,

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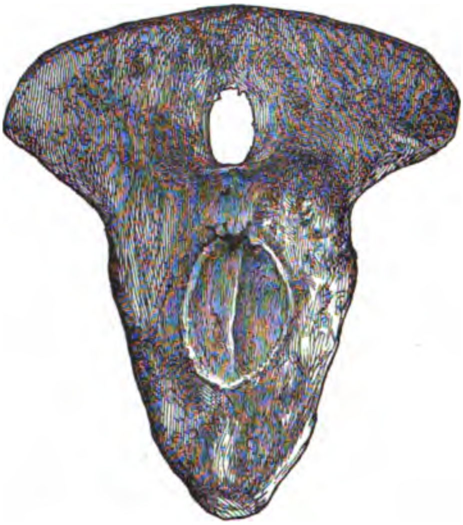
[1] *Natural History of the Sperm Whale*, London, 1839.

[2] *History and Description of the Skeleton of a Sperm Whale*, Sydney, 1851.

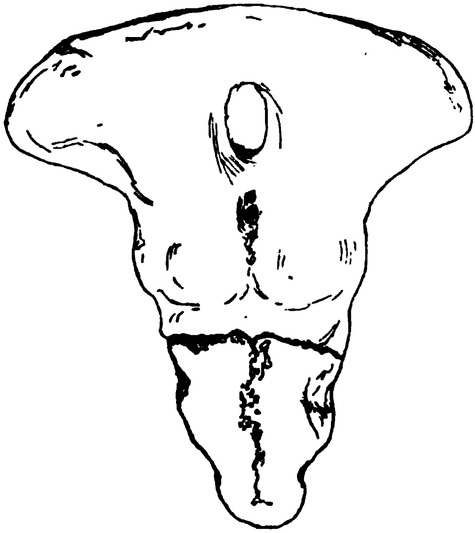
[3] *Trans. Zoological Society*, London, 1868.

[4] I may refer to my account of this animal in *Proc. Roy. Soc.*, Edinburgh, January 28th, 1872, for a fuller description of its characters.

both from side to side and from above downwards. The lateral borders vary in thickness, but are 4 to 5 inches in diameter at the thickest part. Each lateral border presents four well-marked articular surfaces for the cartilages of the four anterior ribs. An oval hole, 6½ inches in length by 4 inches in its greatest transverse diameter, is situated in the middle of that part of the bone which corresponds to the manubrium, and 4½ inches posterior to this hole a much smaller foramen pierces the entire thickness of the bone. From this smaller hole a mesial and two lateral grooves, the latter of which were in all probability for the lodgment of bloodvessels, pass for some inches backwards along the inferior surface of the bone. With the exception of the mesial foramina and groove, the bone presents no other indication on its inferior surface of its original bilateral subdivision, but on the superior surface the posterior segment is marked at its anterior end by a mesial fissure 1½ inches in length, behind which a mesial surface groove extends to the apex of the bone. On the inferior surface there is no indication of the original transverse segmentation. On the



A. Inferior surface of sternum of Skye Sperm Whale.



B. Outline sketch of the superior or thoracic surface.

superior surface, 19 inches in front of the posterior end, a deep transverse fissure passes across the bone through the middle of the third pair of costal articular surfaces, but there is no trace of the original separation of the first and second pieces from each other.

The extreme length of the sternum is 50 inches; its transverse diameter at the articulation of the first pair of ribs is 40 inches; at the second pair 22 inches; at the third pair 18 inches; at the fourth pair 14 inches. If a transverse line between the second pair of costal articular surfaces be regarded as marking the original line of separation of the first and second transverse segments of the bone, then the length of the manubrial segment would be 24 inches, whilst that of the second segment would be only 7 inches. The length of the third transverse segment of the sternum, 19 inches, induced me to examine carefully this part of the bone to see if any evidence of an original subdivision into two or more smaller transverse segments existed, but I failed to detect any marks of such subdivision. Moreover, I find that Prof. Flower has already shewn that great differences exist in the length of the terminal segments of the sterna of the sperm whales which he has examined. In a specimen from Tasmania the length of this segment is 14¾ inches, whilst in the Caithness Cachalot the hinder piece is represented by a median spheroidal nodule of bone 4 inches in diameter, imbedded in a mass of dried cartilage. The terminal piece of the sternum in the Sperm Whale is therefore variable in its length, and the greater dimensions in the Skye specimen are without doubt due to the age of the animal having permitted complete ossification of the cartilaginous matrix to have taken place. For convenience of reference I may append a tabular statement, compiled from my Notes on the occurrence of the Sperm Whale in the Scottish Seas in the *Proc. R. S. Edinburgh*, Feb. 6th, 1871, and Jan. 29th, 1872, in which I have collected ten well-authenticated cases of the occurrence of this animal on the coasts of Scotland.

Locality.	Date.	Authority.
Hoxay, Orkney	9th or 10th cent.?	George Petrie
Limekilns	1689	Sir R. Sibbald
Cramond..................	1701	Jas. Paterson
Monyfeith	February, 1703	Sir R. Sibbald
Ross Shire	1756	Sir W. Jardine
Cramond.........	1769	Jas. Robertson
Hoy Sound, Orkney ...	About 1800	George Low
Oban	May, 1829	Wm. Turner
Thurso, Caithness......	July, 1863	J. E. Gray and W. H. Flower
Loch Scavaig, Skye ...	July, 1871	Wm. Turner

TISSUE METABOLISM, OR THE ARTIFICIAL INDUCTION OF STRUCTURAL CHANGES IN LIVING ORGANISMS. BY W. AINSLIE HOLLIS, M.D., *Cantab.* PL. XVII.

ACTINIÆ.

IN the following pages I propose to give the results (as far as they have gone) of a series of investigations upon the structural changes induced in these and other living organisms by artificial means. Before, however, offering a detailed account of the method of enquiry pursued and of the experiments performed, I shall in all cases briefly recapitulate the histology of the principal structures involved in these tissue-changes.

Their integument. Cilia.—The integument of the young anemone (Actinia mesembrianthemum) is covered with ciliated epithelium (Fig. 1). In the adult this coating is not always present, although it appears difficult to assign a time for its disappearance. The ciliated structures invest without change the stomach[1] and perivisceral cavity. The cilia are not constantly vibratile, but appear to have spasmodic periods of motion. They are, I think, undoubtedly prolongations of the endo-plasmic substance, which under certain conditions can be ejected to a considerable distance from the integument (see Fig. 2)[2], or retracted beneath it.

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[1] M. Hollard admits that the epithelium of the stomach is ciliated (Monograph. Anat. du Genre Actinia, *Ann. des Sc. Nat.* 3ᵉ. Ser. xv. p. 276), although he says that the integumentary epithelium is "nullement vibratile" (p. 266). I find, however, that Erdl (*Müller's Arch.* 1841, p. 423) has seen cilia on the integument of actiniæ.

[2] The view that the cilia are only extensions of the endo-plasma receives support from observations on the animalcules (foraminifera?) inhabiting the cast-off skins of actiniæ (Fig. 4). In these creatures the cilia serve both as organs of locomotion and prehension. It is by such means that the animals adhere to or move along any solid substance they come in contact with; when, on the other hand, the creatures are floating freely in the water, these organs by a rapid vibratile motion both propel them forwards, and serve to waft floating particles of nutriment towards them. The cilia are capable of retraction within their shelly covering, and each one when in motion describes a gyrating figure with its free extremity.

The whole of the integument of the anemone possesses (as is well known) both a sensibility to the action of stimuli and the power of contraction.

Muscular fibres.—Immediately beneath the superficial cilia is a layer of plane muscular fibres placed with their long axes at right angles to the surface, and attached by their inner extremities to a basis of tough fibrous tissue (Fig. 1). Passing still inwards we next meet with a layer of circular fibrils connected by tough fibrous tissue and bathed in a muco-gelatinous fluid[1].

Fluid elements: their movements.—This fluid is uncoagulable either by heat or the action of nitric acid; and it consists of two parts, a neutral tenacious hyaline fluid and semisolid corpuscular elements of various shapes and sizes (Figs. 3 and 5). It is in these elements that we find frequently exhibited a pulsating and rotatory motion, although I shall hereafter shew that this property is not peculiar to these bodies. The movements vary both in rapidity and force, but they average about 100 pulsations per minute, and are increased in force and rapidity by the addition of diluted alcohol to the water in which they are placed. Acetic acid destroys the motion rapidly without greatly changing the shape or appearance of the corpuscles. Besides these pulsating corpuscles, there are others undistinguishable, as far as I can ascertain, in shape or constitution which are not endowed with this property. Many of the corpuscular bodies are of a spheroidal shape and about the size of ordinary lymph corpuscles (leucocytes)—the contents of many are nucleated, of some hyaline, of others granular. Other corpuscles (and they are by far the most numerous) are of an irregular shape and appear to be amorphic masses of the creature's substance, containing in most cases corpuscular elements of a shape and size corresponding to those previously described, and yet possessing in many instances a single pulsating motion throughout their whole mass. The only definite bonds of union in such agglomerations of corpuscular elements beyond the fact of mere contact appears to be the possession of a single pulsatile movement: some masses, however, although their elements appear in close union, possess two or more centres of pulsation differing from one another in rapidity and force. While attempting to localize the structures in which these phenomena occur, I lately observed in the liquid expressed from the recent section of a healthy anemone (A. mesembrianth.) that this pulsatile property was not confined to the corpuscular elements of the fluid, but in many instances resided in localized patches of the hyaline muco-gelatinous fluid in which the corpuscular elements were suspended. I am now of opinion that it is in this fluid that we must in all instances look for the cause of these pulsations. The movements consist of a rhythmical contraction of the elements of this hyaline plasma around a local centre, and the movements of the semi-solid corpuscles are probably due to their suspension in, or invasion by, this contractile fluid. What determines the centralization of the motion and the amount of fluid affected in each case by it I have not ascertained.

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[1] I have not met with the longitudinal fibres noticed by most writers; cf. Von Siebold, *Comp. Anat.* (Tr. Burnett), I. 41.

Perivisceral cavity.—If we continue our dissection and pass still further inwards we arrive at the internal ciliated lining of the perivisceral cavity. Here the cilia are not always readily seen in the adult animal, but their presence in several dissections I have undertaken did not admit of a doubt. The perivisceral cavity with its membranous septa and convoluted tubules need not detain me long. The latter, however, must engage our attention for a short time. When removed from the body of a healthy animal these tubules are of a pale fawn colour, somewhat darker in the centre than at the edges, and they exhibit slow vermicular movements. Their general appearance under a low power may be seen in Figure 9, although in this case the tube was undergoing granular degeneration. All severe injuries to the integument of the animal are attended sooner or later with the escape of a bundle of these organs, and in some cases, even where no injury has occurred, they have succeeded in making their way through the tissues and in escaping outwardly. These tubes are invested externally with several layers of columnar organs (*bacillæ*) set at right angles to tangents to their surface. The bacillæ can be extruded from the surface under stimulation[1] (Fig. 2 *b*), and they are embedded in a soft fibrillar tissue which also contains corpuscular and granular elements. Some of the corpuscles are of about the same size and shape as the compound granulating corpuscles of inflamed tissues in man. The tubules are covered with cilia, of varying lengths, which apparently have the usual powers of retraction. They are exceedingly delicate and hyaline in appearance, and on this account may readily be overlooked. The prolongation of these organs under stimulation from the bacillar circumference of the tubules has given to the latter their popular name of 'thread tubes.' If these tubules possess (as is usually supposed) excretory functions they have also others of equal (if not greater) importance, one of which is closely connected with the process of repair after injury. Besides the circumference of the tubules, there are several other localities on which we find bacillæ. In the anemone I have alluded to (A. mesembrianthemum), there are some peculiar blue bead-like prominences at the base of the outer tentacular ring closely beset with these organs in whorls. When viewed from above (Fig. 22) they have the appearance of a thick growth of setæ. The bacillæ appear to be closely connected with the ejectment of cilia from the endo-plasm, if we may judge from the frequency with which they are found attached when removed from their natural site to a thread-like prolongation of this material.

Lastly, it behoves me to notice the various parasites which inhabit the muciform débris enveloping from time to time the body of a healthy anemone, after which I shall proceed to a detailed account of my experiments.

Their parasites.—These parasites are of four kinds:

a. *Vermicular animals* (Fig. 4 *b*) of various sizes and somewhat similar to *oxyurides* in form. They have an alimentary canal extending from their pointed anterior extremity to within a short distance of their more obtusely-shaped caudal end where the canal opens exteriorly at the side of the body. The minute anatomy of these creatures I have not been able to make out fully, but both terminations of the alimentary canal appear guarded by sphincters; and there are some organs of a greenish yellow colour on either side of the intestines with possibly hepatic functions. Their method of propagation I have been unable to study.

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[1] The nettling organs of actiniæ are probably only these bacillæ. Cf. Wagner, *Müller's Arch.* 1847, p. 195, Taf. VIII.

b. *Ciliated animalcules* (foraminifera?) covered with a turbinated shell above, armed beneath with two closely-set rows of cilia along the inner edge of the shell, and also with other ciliaform pseudo-podal organs both anteriorly and posteriorly (as before-described). The creatures are seen of various sizes, and appear occasionally to propagate by fission (Fig. 4 *a*).

c. *Locomotive corpuscles* of spheroidal and oval shapes. These corpuscles originate as highly refractive granules, and pass through various grades of development until they eventually become oval-shaped, fluke-like bodies, endowed with independent locomotive powers. Their motion appears to be due both to peristaltic contractions of their bodies, and to the prolongation posteriorly of short offsets of their plasmic bodies, and the subsequent contraction of these organs, by repeating which movements they are probably pushed along. In the early or spheroidal stages of their growth, all parts of their bodies appear indifferently to be foremost in the course of locomotion, but later in life they invariably progress with their thin anterior or cephalic extremity in front. These creatures, although occasionally found in the cast-off membranes of a healthy anemone, are mostly found in the decaying tissues of disease, and are then frequently accompanied posteriorly (as I shall hereafter shew) by the small granular corpuscles found in such tissues, and to which they appear to have a great attraction.

d. Excessively minute *vibriones* about the size and shape of detached cilia (Fig. 18). These creatures escaped my notice for some time owing to their minuteness and their transparent nature. They (although placed in this list) ought probably to be classed as solely parasites of disease. I shall have hereafter occasion to refer to them as such. They progress by rapid vermicular movements.

I shall now give a detailed account of the experiments I have instituted with a view to shew the structural changes (or tissue metabolism) which can take place in the various parts of the organism I have described.

Experiment 1. *The anemone transfixed by a silver wire.*—September 28th, 1871. A silver wire passing through the alimentary cavity of an anemone (A. mesemb.), transfixed the animal, and the two extremities of the wire were brought together and twisted. About an hour after the operation the animal appeared entirely to have recovered from the shock of the operation, and it swallowed with avidity some raw mussel and digested it. It, however, soon appeared to have a greater tendency to change its position in the tank in which it was placed than had any of its associates. In its peregrinations the wire was rendered taut, and greatly indented and distorted the stomachal cavity by a resistance through friction against the sides of the vessel to the onward motion of the creature. Notwithstanding these unnatural conditions of life, the animal retained its digestive and locomotive powers unimpaired for three weeks. At the end of this period it became more sluggish in its habits, and was found frequently closed and coated with a thick covering of tenacious débris; when expanded its tentacles were lax, feeble, and insensible to gentle stimuli. Between four and five weeks after the operation the wire by its pressure had invaded the lining membrane of the stomach, and was found lying free in the perivisceral cavity surrounded by a granular débris. On November 30th, this state of affairs terminated in the passage of the wire through the integument. The animal was now in a very sickly condition, it refused its food, and although partially expanded its body was lax, flattened and almost entirely insensible to stimulus, the tentacles were small and slender, the edges of the wound were ragged, pultaceous, and covered with a muciform non-albuminous fluid of a yellowish green colour. This fluid when examined microscopically was found to contain a large number of locomotive corpuscles (as described above, p. 385), as also other stationary nucleated corpuscles and granular débris (Fig. 7). Acetic acid appears in most cases to destroy (or greatly to clarify) the corpuscular envelope and leave the nucleus unaffected. The locomotive corpuscles appear to have a tendency to pass from the diseased tissues into the still healthy structures of the creature's body, and this locomotive power is obtained by a vermicular motion, by which they appear capable of 'worming their way' (to use the expression) into all parts of the anemone. It is probably owing to this action on the part of these parasites that all sloughing surfaces in the actiniæ that I have examined have invariably had a tendency to spread. In the course of their movements they seem to separate, and disintegrate the tissues with which they come in contact, and thus they assist in producing corpuscular and granular degeneration of those structures.

Experiment 2. *The application of blistering fluid.*—December 14, 1871 (9.45 p.m.). An actinia (A. mesembrianthemum) was taken from a vessel in a semi-closed state, and was placed upon a flat glass. A very small quantity of Liquor Epispasticus was applied to the upper surface about midway between the tentacular orifice and the base of the animal. A minute after the application, although no change was observable in the colour of the creature's integument at the spot, it was considerably elevated above the adjacent tissues. After the animal had been thoroughly washed it was replaced in the vessel of sea-water whence it was taken before the operation.

December 15th (2 p.m.). The affected spot of a bluish white colour, swollen and covered with a shreddy muciform débris of a brown colour. (Figs. 11 and 12.) The following day (38 hours after the application of the blistering), the spot was still more prominent, of a brownish colour, and covered at its base by a thick greyish-white semifluid mass. Sixty-two hours after the operation (Fig. 13), numerous locomotive corpuscles were to be seen in the muciform débris. The general tissue changes appeared to consist at this stage of a great excess of the corpuscular and granular elements, the former were of various forms and sizes, some appearing similar to the compound granulation corpuscle of human inflammation, others to leucocytes, and others to the highly refractive granules before described (p. 385)[1]. There were also to be seen several of the bacillar elements before noticed. The locomotive corpuscles appeared as usual to have a tendency to force themselves into the still healthy tissues adjacent to the affected part, and they were mostly accompanied by one or more small corpuscular elements posteriorly. These latter elements appeared to have a great affinity for the corpuscles, as they were frequently observed to be temporarily attached to the locomotive corpuscles during their peregrinations. [For some weeks I considered these so-called locomotive corpuscles to be the ordinary spheroidal corpuscles of disintegrating tissues endowed with motive powers. I am now, however, convinced of their parasitic origin. It is possible to rear these creatures upon the decaying tissue-débris of an anemone, when the organic matter containing them is placed in a vessel entirely separate from all other living beings. It can then be readily demonstrated that each oval corpuscle was originally a highly refractive granule endowed with a slightly pulsatile motion[1].]

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[1] Dr Ferrier has lately shewn that certain highly refractive granules in blood of vertebrates are possibly sarcinæ. For controversy on this subject, see *Brit. Med. Journ.* Jan. 27 and Feb. 3, 1872.

Experiment 3. *Incision.*—December 24, 1871 (1 p.m.). Incised with a clean knife the integument of strawberry anemone, at a part where the animal was above the surface of the water. Immediately after the incision the surrounding integument contracted in longitudinal and transverse furrows, and the surface of the wound became depressed. A small portion of the subintegumentary tissue floating in its own plasma was submitted to examination, and was found to consist of fibrillæ, a few spheroidal stationary corpuscles of various sizes, and here and there a bacilla.

The application of nitrate of silver.—The injured part was next cauterized by nitrate of silver: in ten minutes the part was considerably whitened and depressed. Dec. 25, morning. The incision and cicatrix still depressed. 11 p.m., a prominent piece of tissue in the centre of the depression.

Dec. 26 (noon). The prominent piece of tissue above noticed was readily detached and placed under the microscope for examination. The incised wound was quite healed, the scar still slightly depressed; it had not been under the water since the operation. The scab (or prominent piece of tissue removed) consisted of fibres in a granular condition; no locomotive and but few stationary corpuscles were seen, the latter to some extent blackened (possibly by the nitrate of silver) (Fig. 14).

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[1] Fig. 17.

Experiment 4. *Piece excised, movement of particles of carmine.*—December 27 (10.30 a.m.). After carefully wiping an anemone I excised a small piece of integument and laid bare the perivisceral cavity with its convoluted tubes. I placed the excised portion on a clean glass slide and added a drop of clean sea-water. On microscopical examination a certain amount of pulsation was observed in the neighbourhood of the excised portion on two sides, as shewn by the movement of free particles of carmine (subsequently added to the water). No locomotive or pulsating corpuscles were seen; the muscular fibres with their long axes perpendicular to the surface were clearly defined, as also a considerable number of stationary corpuscles of various sizes. (The anemone was somewhat sickly when operated upon.) Dec. 28 (1 p.m.) The edges of the wound inverted, some of the convoluted perivisceral tubes upon the outer surface of the wound; at one corner the edges appeared to be somewhat adherent to each other. A microscopic examination revealed no further changes than those observed yesterday.

The application of Liquor Epispasticus to the wound.—Dec. 30 (12.30 p.m.). Wound still unhealed. A small portion of the débris of wound examined. It was found to consist of corpuscular and granular matter; no locomotive corpuscles. The wound was next touched with the Liquor Epispasticus. The anemone was then washed and placed in fresh sea-water. The wound after the application of the Liquor Epispasticus was closed by the protrusion of a fresh quantity of convoluted tubes. The integument, which was accidently touched at the same time by the fluid, was pale and slightly elevated about the adjacent parts immediately after the application.

Dec. 31 (10.30 a.m.). The wound and surrounding integument touched yesterday were covered with a shreddy pultaceous mucus. The contour of the extruded convoluted tubes was nearly lost. Upon microscopic examination numerous stationary corpuscles and highly refractive globules were seen; associated with these were some bacillæ (undergoing a granular change) and several small masses of granulation (Fig. 15); acetic acid did not appear to affect these granules. There were not locomotive or pulsating corpuscles. Jan. 3, 1872 (10.30 a.m.). The convoluted tubes near the wound appeared to have undergone complete granular degeneration. Jan. 6, 1872 (1 p.m.). The animal was very sickly, although it was still alive, as shewn by the partial expansion of its tentacles during the last few hours. The wound, as well as the rest of the animal, covered with a thick shreddy mucus. On microscopical examination numerous corpuscles were seen of various sizes, many of these possessed locomotive and pulsatile properties, the former were of a spheroidal shape mostly and of small size (Fig. 16). Movements were noticed at the rough edge of a convoluted tube, no cilia apparent; also a pulsation was seen in several masses of amorphous plasma; in some instances these movements could be assigned to the implication of a locomotive corpuscle in their substance. Jan. 12 (2 p.m.). The wound covered with a dusky diffluent slough, composed of large stationary (compound granulation) corpuscles and bacillæ, locomotive corpuscles of small size and a few clusters of the refractive granules previously seen. Jan. 14 (morning). The slough from the wound found to contain a large number of exceedingly minute vibriones (Fig. 18). They were about the size of ordinary cilia of a hyaline appearance and endowed with rapid vermicular movements. They frequently were observed to adhere closely for some minutes to a stationary spheroidal corpuscle. There were also several corpuscles (about the size of leucocytes in man) arranged in rows, their contents were granular. A few bacillæ, large granulation corpuscles, and granules completed the list of objects seen. There were no locomotive or pulsating corpuscles observable in the part examined.

Jan. 19 (1.30 p.m.). The slough was found to contain locomotive corpuscles of various sizes, vibriones, stationary corpuscles and granules. The creature barely exhibited signs of vitality.

Experiment 5. *The application of blistering fluid to a portion above the surface of the water.*—December 28 (1.15 p.m.). A part of the strawberry anemone (*A. mesembrianth.* operated on previously, see Experiment 3) which was above the surface of the water was touched with *Liquor Epispasticus.* A minute after the operation the integument was raised and swollen at the part (which was near the base), and the rest of the integument between the point of application and the tentacular ring was wrinkled into fine longitudinal folds.

Dec. 29 (12.50 p.m.). The wound somewhat elevated, the integument over it of a brighter colour and of a more irregular outline than natural. On touching the place with a steel style the surface was found to be soft and friable, and the subintegumentary tissue fibrous and of a yellowish green colour. The superficial layers when examined microscopically appeared to be composed of broken-up bundles of muscular fibres with stationary corpuscles (Fig. 19). On the addition of acetic acid the fibrils shrank, and it was in many cases possible to see their gradual disintegration into the corpuscular elements (Fig. 20). Some of the stationary corpuscles (before the addition of the acid) appeared to have amæboid movements in their substance, but they were destitute of locomotive powers. The superficial slough (*a*) was placed in sea-water separately. Some of the fluid obtained from the subintegumentary fibrous tissue (after the removal of the slough) was next examined, it was found to contain numerous particles of plasma of various shapes. There were no locomotive corpuscles. December 30 (10 a.m.). Slough (*a*) re-examined after remaining all night in fresh sea-water. Appearance similar to yesterday, no locomotive or pulsating corpuscles. The cicatrix of the strawberry anemone greatly depressed, appearance of the wound the same as yesterday. Débris from the freshly scraped surface of the scar was submitted to microscopic examination, appearance similar to that of the fluid examined yesterday. The wound had become covered with sea-water. The slough (*a*) (of yesterday) was replaced in a separate vessel of sea-water.

December 31, morning. One or two vibriones and a few ciliated animalcules (see p. 385) in slough (*a*) appearance, otherwise as it was at the two preceding examinations. The cicatrix tissue over the wound assumed the appearance of a delicate semi-fluid mass similar in appearance (but not in consistence) to the convoluted tubules before described, and consisting of an external envelope of granules, corpuscles and bacillæ, with a core of finely granular and fibrillated matter (Figs. 2 and 9).

January 3, 1872. The cicatrix of subintegumentary tissue was found elevated and partly detached. On removal a mass of convoluted tubules was seen below it. The cicatricial tissue was examined microscopically and found to consist of large stationary corpuscles, and a few pulsating ones; there was also an admixture of granular débris and fibrils, the last in a granular condition.

January 6 (1.30 P.M.). A fresh slough formed over the wound, this was readily removed. It consisted of large pale semisolid hyaline corpuscles. There were no movements observable. The anemone in a fairly healthy condition.

January 13th (morning). The anemone sickly. A portion of the integument in a state of slough near the oral orifice, this was accompanied by the protrusion of convoluted tubes. The original wound covered with a diffluent muciform slough superficially, containing a few ciliated animalcules and locomotive corpuscles, also some stationary ones of large size. The deeper layers at the same spot composed of convoluted tubes, which ejected thread-like processes and bacillæ (Fig. 2), some of the latter attached to the former. The ejection of threads was much assisted by the addition of a small quantity of methylic alcohol to the water. There was also a considerable amount of movement near the edges of the tubules, but in this instance I could perceive no cilia to give rise to it.

January 20 (10.30 A.M.). The whole creature for several days in a contracted lowly vitalized state, and covered from time to time with a thick muciform membrane, containing hyaline fibres and a few (locomotive and stationary) spheroidal corpuscles of small size. The wound discharged a green puriform fluid containing large hyaline corpuscles, smaller ditto with dark contents, and numerous granulation corpuscles, also several clusters of granules similar to those previously described (p. 389). There were no locomotive or pulsating corpuscles. Acetic acid appeared in some cases to set free the clustering granules. With tincture of iodine they turned a brown colour more readily than did the hyaline corpuscles. Iodine and sulphuric acid produced in them a bluish-black tint.

January 24. The tissues about the wound very offensive to the smell and diffluent. Stationary corpuscles of various sizes to be seen with a few locomotive corpuscles. The pulsating portions of a fresh section of the animal of all shapes (Fig. 3). The pulsation evidently due to local contractions of the hyaline intercorpuscular plasma.

Summary.—From the above experiments it is evident that the tissues of actiniæ are amenable to the influence of various physiological agents, and that the sequence of pathological tissue-changes induced by such means possesses many points of similarity to those structural changes which in the higher animals are named 'the process of inflammation.'

The application of an irritant (such as blistering fluid) induces in the first instance swelling of the tissues, next disintegration of them; thirdly (if the cause of the irritation be prolonged), there is the production of a greenish-yellow muciform fluid containing numerous corpuscles and granules. These corpuscles are closely similar, as regards size and appearance, to the leucocytes, granulation corpuscles and granular débris of inflammation in man.

Conclusion.—As such events follow the application of stimuli to the bodies of animals in whom no definite nervous or vascular system is present, we must conclude that these changes are induced in them irrespective of any influences usually ascribed to such systems.

DESCRIPTION OF THE FIGURES.

Fig. 1. The partly expanded tentacle of a baby anemone (A. mesembrianthemum) shewing the integumentary covering (Camera lucida, × 95).

Fig. 2. Portion of a convoluted tubule from the slough (described at p. 392) shewing the thread-like ejectments and bacillæ—'*a*' free edge of convoluted tubule—'*b*' bacilla with thread attached—'*c*' threads —'*d*' stationary corpuscles. (Jan. 13, 1872.— × 250.)

Fig. 3. Corpuscular masses from the fresh section of an anemone —'*a*' '*a*' amorphous masses of pulsating plasma, containing spheroidal corpuscles in their interior—'*b*' two spheroidal pulsating and rotating corpuscles—'*c, c, c*' stationary corpuscles. (× 250.)

Fig. 4. Parasites inhabiting the cast-off integument of healthy anemones—'*a*' Ciliated animalcule—'a^{*}' its under surface, 'a^{**}' front and back views, 'a^{***}' one in the process of fission—'*b*' Worm-like parasite—(1) cephalic, (2) anal extremity—'*c*' (?) a young actinia. (× 250.)

Fig. 5. Corpuscular fluid expressed from subintegumentary tissue after the removal of a slough (see p. 391), '*a*' and '*b*' the same corpuscle. (× 250.)

Fig. 6. Corpuscles and fibrils from the same slough as Figure 5, twenty-four hours later. (× 250.)

Fig. 7. Motionless corpuscles from the stomachal membrane in a state of slough (see Experiment 1). (Dec. 15, 1870— × 250.)

Fig. 8. Actinia mesembrianthemum after its tissues had been sloughed through by a silver wire (see page 386)—'*a*' yellowish green puriform matter—'*b*' oral orifice—'*c*' tentacular ring, with the slightly protruded tentacles. (Actual size.)

Fig. 9. Granular degeneration of a convoluted tube shewing the disintegration of its substance into bacillæ and corpuscles. (× 95).

Fig. 10. Membranous débris from a healing surface—'*a*' locomotive corpuscle—'*b*' stationary corpuscles—'*c*' folds of membraniform tissue. (× 400.)

Fig. 11. A. mesembrianthemum thirty-eight hours after the application of blistering fluid to its substance—'*a*' exudation tissue (brown)—'*b*' Sloughing membrane (bluish white).

Fig. 12. Same viewed from above. (Both figures are of the natural size.)

Fig. 13. Tissue formation and débris (62 hours) after the application of Liquor Epispasticus to A. mesembrianthemum—'*a*' locomotive corpuscle—'*b*' tissue formation—'*c*' bacillæ (?) '*d*' granulation corpuscles. (× 400.) See p. 389.

Fig. 14. Fibrous tissue from the scab formed (48 hours) after the application of the nitrate of silver to an incised wound of A. mesembrianthemum—'*b b b*' a few stationary blackened corpuscles (× 250.)

Fig. 15. Granular débris (24 hours) after the treatment of incised wound by Liquor Epispasticus. (× 250—see p. 389.)

Fig. 16. Locomotive corpuscles from the same wound as above (Fig. 15) one week later. (× 250.)

Fig. 17. Locomotive corpuscles bred in decaying animal matter (the refuse of actiniæ, &c.). (× 250—Jan. 24.)

Fig. 18. Active vibriones from the same wound as Figures 15 and 16—'*a a a*' vibriones—some of which seemed to be attached to stationary corpuscles—'*b*' a row of granular corpuscles. (× 400—Jan. 14, 1872.) See p. 390.

Fig. 19. Débris (24 hours) after the application of Liquor Epispasticus to Strawberry Anemone—'*a a*' muscular fibrils of superficial integument—'*b b*' stationary corpuscles. (× 250.) See p. 391.

Fig. 20. Same as preceding figure after the addition of acetic acid—'*a a*' fibrils breaking into corpuscles. (× 250.)

Fig. 21. Tissue débris (62 hours) after the application of Liquor Epispasticus to A. mesembrianth. (× 400.)

Fig. 22. Bacillæ from the blue bead-like organs at the base of the tentacles of A. mesembrianthemum—'*a*' Separate bacillæ—'*b*' the same in position. (× 250.)

Fig. 23. The same organ at the commencement of suppuration—'*a a*' granular bacillæ—'*b b*' spheroidal rotatory and locomotive corpuscles—'*c*' oval-shaped locomotive corpuscle. (× 250.)

THE HOMOLOGUE OF A MANDIBULAR PALP IN CERTAIN INSECTS. By W. AINSLIE HOLLIS, M.D., *Cantab.* (Pl. XVIII.)

THE mandibles of insects are considered to be without a homological representative of the palp so commonly observed in the crustaceon arthropods. In the latter class this sensitive organ is usually well developed; and (as is well known) it serves the purpose of not only directing the food into the mouth, but also of retaining and manipulating it when it is there. In the Lobster (Fig. I.) the palp arises from the superior surface of the mandible, and curving forwards and inwards passes ultimately downwards in a groove on the inner or grinding surface of the mandible, dividing this side of the organ into two distinct portions, an anterior or incisor, and a posterior or triturating part; at the upper part of the incisor edge is a small notch, which divides the edge into two parts, and has possibly a peculiar homological significance. In the aquatic members of this class the palp thus derives much of its peculiar importance from its function of directing the floating portions of food to the mouth; among the terrestrial crustaceans there is no need of such assistance. Correlated with its diminished utility is a diminished development of the organ. The isopol wood-louse (*Porcellis scaber*) (Fig. II.) furnishes an example of this law. Here the triarticulate palp of the lobster is represented by a tuft of hairs, occupying, it is true, a position closely similar; that is, it is situated in a groove on the inner and upper surface of the tridentate mandible, but differing in form and constitution so greatly from the lobster's palp, as to be unfitted for other than sensitive functions. Although the two palpal organs above described differ so greatly in their anatomical details, they are nevertheless admitted by naturalists to be homologically similar.

I shall now pass to the insects. At the base of the mandible of the coleopterous staphylinidæ observers have noticed a peculiar appendage consisting of a series of feathery tufts set closely together (Figs. III. *b*, and IV.), and forming a conical brush with its apex pointing inwards. The base of the cone is affixed to a delicate homogeneous membrane, which is tightly stretched across a depression in the chitinous framework towards the base of the mandible. This brush, placed as it is on the inner surface of the mandible, and lying in a furrow behind the probable representatives of the incisors of the lobster, occupies the same relative position as regards the teeth of the cock-tail beetle (*Ocypus oleus*), as does the hairy tuft in the mandible of the wood-louse. Judging from their situation and constitution, I think we must assign similar functions to these tufted appendages of the mandibles of the wood-louse and cock-tail beetle.

Among the mandibulate insects these hairy tufts are very generally present, although they differ considerably in size and structure. In the water-beetle, *Hydrous piceus* for instance, the palpal homologue (if I may use the term) consists of a tuft of stiff bristles placed in the usual position (Fig. VIII. *b*) on the inner surface and towards the base of the mandible; but it is supplemented by a sort of fan-shaped rasp, formed of a double row of sharp teeth, the under-row of which is united for two-thirds of the length of the teeth by a delicate membrane, and forms an organ resembling the dorsal fin of a perch. In this case I conclude that besides their probable function of sensation, such appendages assist in the mastication of the food. On the other hand, in the Stag-beetle (Fig. VII.), these hairy appendages are almost absent; correlated to this may be the fact that these insects live almost entirely by suction upon the juices of the plants which they have wounded with their mandibles. In the orthoptera (Figs. V. and VI.) I find only a few scanty tufts of hair in the situation before mentioned, and yet they are sufficient to compare homologically with the foregoing insects, especially as the hairs of the cockroach (Fig. VI. *b*) are attached to a delicate basal membrane stretched across a slight depression on the upper and inner surface of the mandible. In the larval forms of lepidoptera I find no corresponding tufts of hair, although there are usually one or two bristles (Fig. IX. *a*) very constantly present on the outer and under surface of the mandible, which possibly may have similar functions to the hairy mandibular tufts in other insects, although differently placed. I conclude, therefore, owing to the frequent occurrence of these hairy tufts amongst the mandibulate insects, their tolerably fixed relative position at the base and upper and inner surface of the mandible, and their structure, that they correspond homologically to the hairy tufts upon the mandibles of isopod crustaceans, and consequently to the palps of the other members of that class.

DESCRIPTION OF THE FIGURES.

I. Mandible of a Lobster (*Homarus vulgaris*), life size.
- *a.* Side view.
- *b.* View of the oval surface.
- *c.* Mandibular palp.
- *d.* Incisor edge.
- *e.* Triturating surface.

II. Mandible of Wood-louse (*Porcellio scabro*), magnified.
- *a.* Tufted anterior palp (new growth).
- *b.* Dentary part of mandible.
- *c.* Tufted posterior palp (old growth).

III. Mandible of Cock-tail beetle (*Ocypus oleus*).
- *a.* Dentary part of mandible.
- *b.* Brush-like palpal homologue.

IV. The palpal homologue in preceding figure highly magnified.
- *a.* Homogeneous membrane.
- *b.* Feathery brush.

V. Mandible of Hearth-cricket (*Acheta domestica*).
- *a.* Dentary portion. *b.* Palpal homologue.

VI. Mandible of the common Cockroach (*Periplaneta orientalis*).
- *a.* Dentary portion. *b.* Palpal homologue.

VII. Mandible of the Stage-beetle (*Lucanus Cervus*, ♀).

VIII. Mandible of a Water-beetle (*Hydrous Piceus*).
- *a.* Dentary portion. *b.* Palpal homologue.
- *c.* Saw-like appendage.

IX. Mandible of a Larva (? *Pieris Brassica*).
- *a.* Mandibular bristle.

A NOTE ON THE GROWTH OF THE MASTICATORY ORGANS OF ISOPOD CRUSTACEANS. By W. AINSLIE HOLLIS, M.D. *Cantab.* (Pl. XVIII.)

I HAVE lately had an opportunity in the course of some dissections of observing the mode of growth in the mandibles and maxillæ of the common Wood-louse (*Porcellis scaber* and *Oniscus asellus*). The newly-formed tooth of the mandible may be first seen (as in Fig. X. *b*) forcing its way along the hollow limb of the old mandible, and occasionally the delicate palp may be detected closely attached to the new tooth. As it passes onwards it assumes the position shewn in the next figure (Fig. XI. *b*). Here the palp, accompanying the young tooth, may be clearly observed. A still later growth is shewn in Figure XII., where the young tooth has almost attained its full development. The maxillæ, with their palps, have a similar mode of growth (Fig. XIII.). From the frequency with which the mandibles may be observed in one or the other of the above stages of growth, and from the fact that a general ecclysis of the integument is by no means a constant accompaniment of such mandibular changes, I conclude that the mandibles are renewed far more frequently than the shelly covering generally, or indeed than the maxillæ; as I have found these organs repeatedly without a trace of any fresh growth, when the mandibles were palpably in one or the other of the above stages of growth.

DESCRIPTION OF THE FIGURES.

X. The mandible of a Wood-louse in the earlier stage of growth.
a. The old dentary part. *b.* New ditto.

XI. The same in a more advanced stage.
c. Newly formed tuft. *d.* The old palpal tuft.

XII. The same in the last stage of growth. The letters refer to the same parts as in preceding figure.

XIII. The maxilla and palp of the same Crustacean.
a. Old maxilla. *b.* Newly formed one.
c. The old palp with its hairy tufts.
d. The newly formed one.

ON SPHYGMOGRAPHY. BY A. H. GARROD, B.A.,

St John's College, Cambridge.

IT is to the happy conception of Marey's, in which he obtained correct amplification of sudden small movements by employing the elastic force of a spring rather than the statical pressure of weights, that we owe the form of Sphygmography, now well known to most students of physiology; and the introduction of this fresh method of research has given a stimulus to the progress of precise thought respecting the circulation of the blood and the action of the heart, which must necessarily prove of extreme value in the investigation of pathological conditions, now quite beyond our grasp.

Marey's original instrument, as constructed by Breguet is so well known, and so many excellent descriptions are accessible[1], that it is not necessary to go into detail regarding it. In most respects it is the best form that has been introduced, and much credit is due to M. Breguet for the excellence of the mechanical construction. This maker has lately introduced a second instrument which has the advantage of removing the chief defects of the original one, and of introducing very little intrinsic error.

The chief objection to the old, or knife-edge construction, as it may be called from the fact that the recording lever is connected with the pulse pad by means of a sharp steel edge, depends on the necessary sliding of that knife-edge on the steel surface below the recording lever, by which means the distance between the axis of rotation of the lever and the point of contact of the knife-edge must vary with every movement of the former; the accompanying diagram shews how this is the case for two different heights of the lever.

In consequence of this imperfection, two traces taken one near the top, and the other lower down on the recording paper

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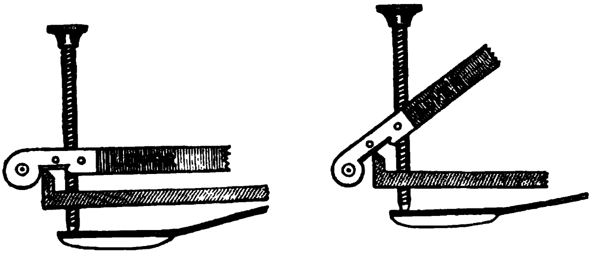
[1] Marey, *Physiologie médicale de la circulation du sang*, Paris, 1863; B. F. Foster, M.D., *On the use of the Sphygmograph in the investigation of disease*, 1866; J. Burdon Sanderson, M.D., F.R.S., *Handbook of the Sphygmograph*, 1867; and others.

Fig. 1.



present characteristics which are in many respects different, and whose differences arise solely from the sliding above mentioned. The lever in the upper trace falls less rapidly than in the lower, as the knife-edge has to slide over a much larger surface in the former, than in the latter where it scarcely moves at all. As a result of this, the length of the first part of the higher trace is apparently greater than it ought to be.

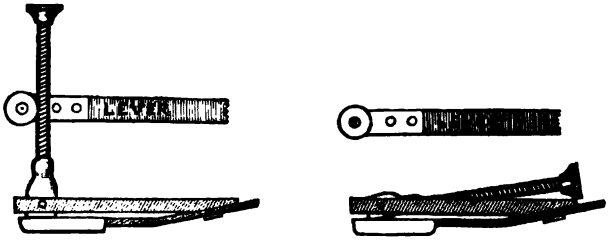
Another objection is, that there is no firm connection between the pulse-spring and the recording lever, so that when the latter is suddenly raised, as by the systolic impulse, the contacts of the lever, intermediate brasswork and pulse-spring, are not maintained, and a "percussion-rise" is seen in the trace. This error is partly obviated by a small spring which presses on the recording lever and tends to keep it in contact with the other moving parts, though this is omitted by some, much to the detriment of the instrument.

Though in the taking of the trace itself, this absence of connection between the lever and pulse-spring is disadvantageous, yet in the applying and removing of the instrument it is of extreme value, for it allows of any amount of pressure being put on the latter, without producing any strain or injurious effect on the former. In practice this quality is invaluable, and it is almost impossible to obtain it in any construction, other than the one under consideration.

Breguet's new sphygmograph is very simple and ingenious in principle, and in practice works admirably. As in the older instrument, the recording lever is fixed to the body of the apparatus by an axis or arbor, but the novelty consists in the manner in which this is brought into connection with the pulse-spring.

The lever is of the third kind, as in the other instrument, but it has no steel surface below it for a knife-edge to play on, and it is, when not in use, entirely disconnected from the pulse-spring.

Fig. 2.



Near the middle of the arbor there is a small circular ring of brass, surrounding it, which has a diameter of about one-sixth of an inch. On its outer surface this ring is grooved and an endless screw is cut in this groove.

There is no brasswork attached to the pulse-spring corresponding to that in the older instrument. In its stead a long flat slip of brass, fixed about two-thirds the length of that spring from its attached end, extends onwards over the ivory pad. Just above this pad a steel screw about an inch long, with a milled-head at one end, is fixed at the other to the unattached extremity of the piece of brass just mentioned, by a hinge, and is so arranged that by means of the pulse-spring it is retained either at right angles to it, or lying along it, on the same principle that an ordinary knife-blade can be fixed half open or closed.

This long screw, when at right angles or nearly so, to the spring, comes in contact with the endless screw cut in the brass ring surrounding the arbor, and as they are of corresponding size, they bite and are retained in contact by the pulse-spring pressing on the fixed end of the screw, which is squared off in such a manner that it shall continue to press slightly backwards when in contact with the ring. It is evident from this construction that any up or down movement communicated to the pulse-pad, produces a corresponding rise or fall in the recording lever. When not in action the long screw can be thrown out of gear, down on the spring as seen in Fig. 2, and it has also a movement which allows of its being turned round, which can be employed as a fine adjustment in regulating the height of the lever point.

In this instrument the distance between the axis of rotation of the arbor and the part of the long screw which is in contact with the ring surrounding it, cannot vary, whatever the distance of the pulse-pad, and therefore no error is introduced in that direction. Also the difficulty in disconnecting the spring from the axis, after the trace has been taken, is very slight; though it requires some little practice to do this, before removing the instrument from the wrist, as it always should be.

This, the rackwork sphygmograph, will probably supersede the knife-edge one by degrees, for the tracings are more uniform and in other respects quite as good as those obtained by the earlier instrument. For cardiograms it is not so advantageous.

With regard to the best means of binding the sphygmograph on the arm, the original method adopted by Marey of lacing it with a silk ribbon to the side-lappets is as efficient as any. The wrist should be always bent a little backwards, and care should be taken that the pad presses on the lower end of the radial artery, not on the superficialis volæ, as is apt to occur if it is fixed too far forwards. The pad introduced by Mr Berkeley Hill enables the correct position of the hand to be maintained with facility, but it is scarcely necessary as a little practice removes all difficulty. It is worthy of notice that better traces can be obtained after the instrument has been applied a few minutes than immediately; for the pad, by its pressure on the skin, drives blood from the small vessels covering the artery and so lessens the distance between it and the pulse-spring.

To record the movements of the lever, it is best to employ highly glazed paper which has been smoked thinly by the flame of a composite candle; and to effect this properly, the paper must be folded on the metal plate which is connected with the running gear of the sphygmograph, and moved quickly up and down in the flame. By this means its edges are not charred and a more uniform film is produced. The pen must have a fine sharp point. A spirit varnish, such as is used for photographic plates, fixes the tracings, if a little is poured over them gently, and the paper is subsequently warmed.

An entirely novel form of sphygmograph has been constructed by M. Longuet[1], which, from a figure in Dr. Loraine's work, appears to possess all the requirements of an accurate instrument, except in the recording portion, where the pen instead of writing laterally, as it might easily be made to do, rests on the paper horizontally and has to change its relation to the body of the instrument whenever the pulse-pad moves in the least. In principle its construction is in a great measure similar to that of the cardiograph in my combined cardio-sphygmograph, which was described in this Journal in May, 1871. It has a dynamometer attached which measures the pressure and its changes throughout the beat.

One of the points in which Marey improved upon Vierordt's original sphygmograph was, that he made his lever write laterally instead of at its tip, by which means he obviated all difficulties connected with an exact up and down movement of the recording pen. But this gives rise to another slight error, which can and must be corrected in comparing the lengths of the elements of the pulse-beat. The lever, when the clockwork is stationary, traces a curved line and not a straight one, the curve being part of a circle, of which the lever is the radius and its arbor the centre. Therefore, when the watchwork is in action, the horizontal relation of points at different heights on the recording paper is not truly represented by straight lines drawn perpendicular to the length of the paper, but by lines projected from these points in curves parallel to that produced by the lever on the paper when it is stationary. These lines can be easily formed after the tracing has been removed from the apparatus, by scratching on it with a needle that is tied to a nail, or a piece of board with two pieces of cotton of the length of the recording lever, one to its eye, and the other near its point, if the tracing be fixed with its lower edge in the same straight line as the nail; for then the paper and nail bear the same relation to one another that the former did to the arbor of the lever when it was being recorded.

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[1] *Bulletin de l'Acad. de Médecine*, 1868, xxxiii. 962.

Dr Sanderson[1], Mr Mahomed[2], and others have introduced different ingenious methods for regulating and measuring the pressure applied on the artery, which they have described in full in their books and papers on the subject; but the desired results can be only approximate, as from variations in the elasticity of the skin in different individuals, and in the same individual under different atmospheric conditions, complications are introduced which cannot be eliminated.

The sphygmograph is a bad hæmadynamometer at its best, and as such its employment will probably diminish. A glance at the work of Dr Loraine[3] will shew that numberless variations in the character of a tracing can be introduced by very small changes in the position, &c. of the subject experimented on. But there is one part of the trace which is not affected in any way by these complications, and that is the relation borne by the *length* of the different portions of each beat to one another. Whether the arm is raised or lowered, whether the pressure is great or small, the interval between the systolic rise and the commencement of the diastolic rise does not vary in the least. These intervals cannot be correctly estimated except by the aid of the sphygmograph; and as the value of any method of investigation is greatest in that direction in which it is least influenced by surrounding circumstances, it is, as it will be my endeavour to prove when considering the tracings themselves, for the measurement of these intervals that we must look for the future value of the sphygmograph.

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[1] *Loc. cit.*

[2] *Med. Times and Gazette*, 1872.

[3] *Etudes de Médecine Clinique. Le Pouls.* Paris, 1870.

SOME REMARKS ON THE ANATOMY OF THE HUMAN PLACENTA. By J. BRAXTON HICKS, M.D. *Lond.*, F.R.S., F.L.S., &c.

THE fact that blood has been found amongst the villi in Placentæ after their expulsion from the Uterus in Labour, has given great weight to the theory of a placental sinus-system. Now should it be shewn that naturally no blood is to be found there, then the support its presence in Placentæ expelled in the normal way appears to give, ceases to be of importance. Let it be for the moment assumed that naturally there is no blood between the villi, and that the Placenta is detached *in utero*, then, surrounded as it would be by blood, it is difficult to consider how it can happen but that some blood should find its way between the villi and become diffused among them; for in nearly every case the decidual membrane is found in some manner lacerated so as to allow the influx of blood; or, as in many cases, some of the Decidua Serotina may be found left attached to the uterine wall. But at the same time it should also be remembered that blood may get between the villi from the fœtal vessels in the rupturing of the villi themselves. Therefore the only way to avoid fallacy remains in examining the Placentæ *in situ*. Then if upon such an examination no blood should be found between the villi, or at any rate very little blood, not more than can be accounted for by the rupturing of one or two delicate villi of the chorion, then the presence of blood amongst the villi in expelled Placentæ ceases to be of importance as an evidence of the placental sinus-system.

But on this point it might be argued that the absence of blood may be owing to to the natural contractility of the Placenta. Then it would be different from other parts of the venous system after death, and certainly of the Uterine decidua itself, for in all the cases related the Uterine veins were found intensely gorged with blood immediately outside of the ends of the villi.

If in addition to the evidence of the mature Placentæ the ovum at the early period should fail to shew the presence of any blood amongst the villi, it would be an additional evidence against the existence of a sinus-system, unless indeed it were argued that the sinus-system was in a transitional state, which has indeed been assumed, but which after repeated examinations of ova in all stages I have been unable to find. In the notes of cases which follow, evidence will be given from dissections *in situ*, from the examination of an ovum at an early period and also from diseased Placentæ.

1*st.* *Dissection of a Uterus at the Sixth Month of Pregnancy.*

It had been open d and the Fœtus removed. The Placenta then occupied more than one-third of the internal surface of the Uterus, extending from nearly the Fundus to nearly the os Uteri. The Decidua Serotina was detached by most delicate touch of a light ivory handle, merely by its weight; every portion was watched under an eye-glass of considerable power.

The attachment was very feeble and held together by two structures, one being bands of connective tissue, the second was by blood-vessels of very small diameter. All the structures were more or less tender, requiring much care lest the villi should be ruptured. No blood whatever issued from any line of the separation, except where those vessels were broken through, and this only in very minute quantities. On carefully examining the intervillal space, *not the slightest trace of blood was to be found.*

2*nd.* *Dissection of a Pregnant Uterus at about the Third Month.*

The Placenta was situated posteriorly, its upper edge being at the Fundus. It was carefully opened on its amnial surface. Not a trace of blood was within among the villi. Water was poured in; it diffused itself all through the interior, *but no blood nor bloody water escaped.* The arteries had been injected with a blue glycerine injection, a little of which was found at a small spot amongst the villi loosely extravasated amongst them; it had entered from a ruptured vessel. Now had any blood been within, some surely must have been visible.

But, further, the colour of the Placenta was almost in every part absolutely white, which was due to the absence of blood in the fœtal villi.

3rd. *Dissection of a Pregnant Uterus at Three and a Half Months of Pregnancy.*

The Placental aspect of the Decidua Serotina was examined with reference to its thickness. The ends of the villi were either exposed in some points or so slightly covered, as to be liable upon slight movement to be exposed. Being anxious to ascertain if any blood was in the intervillal space, the Decidua Serotina was slightly lacerated with much care; upon this, a slight oosing of watery blood took place when pressure somewhat increased.

It is impossible to say what amount of blood might have entered the intervillar space during the separation; water was gently used to wash away that which seemed likely to enter; probably only a small quantity succeeded in doing so. The Placenta was then opened on its amnial surface, as carefully as possible, and a small quantity of blood was seen to exude. In order to see whether the blood came from the villi cut through, or the intervillal space, the Funis was injected with Prussian-blue and size, and it was found that notwithstanding the great care taken to avoid wounding the fœtal vessels, some had been cut through, and from those the blue injection poured forth freely. The quality of the blood was then compared with that of the uterine, and both these with the watery blood in the intervillar space. It was found underneath the microscope that the relative quantity of blood corpuscles was about the same in the two former, whereas in the interplacental space the relative numbers were about 300 times less. Had a sinus-system been the source, so marked a difference would not have existed; half-a-dozen drops would have been sufficient to produce the appearance.

It is difficult to understand why, from the large space amongst the villi capable of being filled and of holding three or four ounces of blood without much distention, there was not a large flow of blood when the intervillal space was opened, or a quantity observable within if a sinus-system exists.

4th. Dissection of a Pregnant Uterus about the Fourth Month.

The patient died from an operation for Hernia. The uterus was opened from below upwards without injuring the Placenta.

Two openings were made into the Decidua Serotina, some little distance from one another. Bright blood flowed from them in small quantities. Water was then injected into one hole, which issued from the other, tinged with blood; as this indicated the presence of blood in the intervillal space, and was apparently of too deep a tinge from that which a wounded villus would cause, a further explanation of its presence was sought for.

On carefully examining the interior of the Placenta, it was noticed that some purple patches, which were visible on the amnial surface, were coagula of blood, situated and extravasated amongst the villi.

But the source of these coagula could not be satisfactorily ascertained—whether it occurred from the rupture of the villi, or came from the maternal side. In any case, had blood been normally present in the intervillal space, there would have been blood universally, either fluid or coagulated, disseminated amongst the villi, not localized patches, as here noticed.

From the distention of one of these patches, when the funic vessels were injected with water, I am inclined to think that the effusion of blood had taken place from rupture of the villi.

A dissection was then made through the uterine wall to the Placenta, and at the point of attachment of the villi to the Decidua Serotina the venous capillaries were large and full of clotted blood in many parts.

5th. Examination of an Aborted Ovum, which came away complete with the Decidual Coverings.

The true Ovum was about an inch in diameter. The Decidua Serotina, which was very thin and transparent, was carefully opened. There could not be found a trace of blood amongst the villi of the chorion, neither was there to be observed any representative of a sinus-system in a transitional state. The villi were free up to their insertion into the Decidua.

6th. *Examination of a Mature Placenta in the state called "Fatty."*

The Fœtus had been alive within a week before delivery. Very little blood had come from the Placenta, not enough to soil the wrapper which enclosed it.

There was a little blood in the curling arteries, but, with the exception of these, there was no trace whatever of blood. The contrast was very marked between the curling artery with the contained blood and the pale yellow bloodless villi.

In the mass the Placenta looked like a cake of fat as to colour, and the Decidua Serotina over its maternal surface gave it a smooth surface something resembling the fat of the kidneys.

Upon opening the intervillal space *no trace of blood* was visible amongst the villi.

The villi in nearly every part were bloodless, their interior was occupied by cells filling them, which had solidified them. Some were undergoing fatty degeneration, but in the greater number abnormal cell-growths were the cause of the change in the character of the villi. Supposing that there was blood normally amongst the villi, how can the change in the villi explain its *total* absence, for amongst the roots of the villi there are interspaces, from which blood could not have exuded so as to leave no trace behind?

7th. *Description of a so-called "Fatty" Placenta.*

The Child had been living up to about a fortnight previous to labour, which took place at full term. The Placenta was pale in colour, no trace of blood between the villi.

The arteries which accompany the decidual processes in certain parts were in contact with the villi, dipping amongst them, and, although gorged with blood, not the slightest quantity extended beyond their walls.

The villi had but little remains of the fœtal blood in their capillaries, here and there was a slight appearance to indicate their course. There were no fatty globules within them, merely an entire absence of blood in them.

This state rendered the absence of blood in the intervillal space a matter of complete certainty.

8th. *Examination of another Mature Placenta called "Fatty."*

The Child had been dead not long before birth, and it was of full size and well nourished.

The Placenta was pale yellow colour. The curling arteries were filled with black blood. There was no blood in the villi, but in the Decidua Serotina and decidual processes the sinuses were full, presenting a marked contrast to the pallor of the villi. *There was not a trace of blood in the intervillal space,* being similar to the before-described specimen.

Water was injected into this space, and escaped through another opening colourless.

In these so-called "fatty" Placentæ the engorgement of the decidual vessels formed a very strong contrast to the absolute absence of blood amongst the villi. The blood was separated off from the villi by the delicate walls of the decidual vessels, so completely that it seemed impossible that communication could naturally exist between the intervillal space and these vessels.

In the examination of Placentæ expelled naturally, I have found a great difference in the amount of blood amongst the villi; and this rule obtained—the *more complete the Decidua Serotina was, the less blood was found within,* and *vice versa.* Anyone can verify this for himself.

I leave the description above given without comment, because to do justice to the whole question would require larger space than it is here intended to occupy. I have here merely endeavoured to shew that blood is at any rate not so frequently found amongst the villi as supposed; which, to my mind, is a far more difficult thing to comprehend, if blood naturally be there, than to understand how it is so frequently there in the naturally expelled Placenta, supposing blood be ordinarily absent.

ON THE SO-CALLED TAILLESS TROUT OF ISLAY.

By Ramsay H. Traquair, M.D., *Professor of Zoology in the Royal College of Science, Dublin.* (Pl. XIX.)

The common Trout (*Salmo fario*, Linn.) of Great Britain is, as is well known, frequently the subject of malformations, of which, sigmoid distortions of the vertebral column, and deficient development of the snout and upper jaw, have hitherto been those most frequently noticed. The abnormal condition of the caudal fin, which characterises the "Tailless Trout of Islay," is, however, of especial interest to the zoologist, apparently affecting, as it does, all the trout inhabiting a certain small lake; and though in itself essentially of the nature of a malformation, this condition would thus almost seem to confer on these fish the distinction of a local variety.

These remarkable trout were brought under the notice of the British Association at the meeting at Edinburgh in August, 1871, by Mr C. W. Peach, who, besides exhibiting specimens, read a short communication on their native habitat and mode of occurrence. From the published abstract of Mr Peach's paper[1] I quote the following:—"Mr Peach stated that the trout he shewed were sent to him by Mr Colin Hay, distiller, of Ardbeg, Islay, taken in Lochnamaorachan, about 1000 feet above the level of the sea: it is supposed to be the highest in the island. It is about an acre in extent, and so shallow that a man can wade through it; the bottom is quartz rock like that of the mountains around it. Several other lochs are near it in which trout are plentiful but none 'tailless.' So constant is this that Mr McKay, a very keen fisher, has never for the thirty years of his fishing experience in this loch taken any but 'docked' ones."

Through the kindness of Professor Turner and Mr Peach I have enjoyed an opportunity of examining two specimens of these remarkable fish from Lochnamaorachan.

The larger of these two specimens measured 10 inches in length. The snout was rather obtuse, and the length of the head from the tip of the snout to the posterior angle of the gill-cover was contained slightly more than four times in the entire length of the body. All the fins seemed rather small, but the most striking feature was the conformation of the caudal. This fin, instead of shewing the usual large broad triangular expansion with thin and delicate, truncate, or slightly emarginate posterior margin, was very short, and rounded off above and below, and with the hinder border rather thick. In the present specimen there is also a slight angular projection or blunt point rather below the middle of the posterior margin (see Figures 1 and 2, Pl. XIX.). Without removing the skin it was at once apparent what the real nature of the abnormal condition was, but this was rendered still more clear, on making the dissection of the caudal extremity of the body represented in Fig. 2. The tail fin is here seen to be composed in all of 42 rays, of which, 13 above and 11 below are as usual short and, except the hinder two in the upper, and the hinder one in the lower series, destitute of transverse articulations. One of them, near the middle of the fin is seen to be evidently composed of two ordinary rays fused together at their proximal ends. The 18 long middle rays, forming the mass of the caudal expansion, differ remarkably from those in the normal trout. They proceed in the usual straight and diverging manner to near the hinder border of the fin, when the extremities of the rays above and below become suddenly bent downwards and upwards respectively, thus converging towards the angular projection of the posterior margin already noticed. This projection is supported by the 11th of the series of long rays counting from above, and which is thus the straightest of all. Nor do those rays end in the fine and slenderly dichotomising manner characteristic of the normal fin, but their bent and somewhat contorted extremities are thick and coarse, and their transverse articulations are much reduced in number. In some cases, one of the branches resulting from the primary bifurcation of the normal portion of the ray stops altogether short, where the stunting of the fin commences, in other cases, the two branches unite once more at their abnormal extremities; and still more remarkable is the fact, that at three different portions of the margin of the fin as shewn in Fig. 2, the extremities of several rays are actually seen to become fused together into one piece.

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[1] *Brit. Assoc. Rep.* Aug. 1871. *Transaction of Sections*, p. 183.

In the present specimen, the remarkable condition just described is by no means confined to the caudal fin, but is exhibited, though in a less degree, both by the anal, and by the pectorals. In Fig. 1 the *anal* is seen to be also rather stunted in its dimensions, and instead of presenting the normal somewhat fan-shaped figure it is rather rounded-acuminate in shape. It is composed of 13 rays as shewn in Fig. 4, of which the 3rd to the 9th inclusive, counting from the front, are abnormal. The apex of the fin, directed downwards and backwards, is supported by the extremity of the 8th ray, towards which the ends of the 3rd, 4th, 5th, 6th and 7th rays converge backwards and that of the anterior division of the 9th converges forwards. The extremities of these rays are thick and coarse, and those of the 5th and 6th are fused together.

The *pectoral* of the right side is small for the size of the fish, measuring only one inch and a quarter in length, and being contained 2½ times in the distance between its origin and that of the ventral of the same side, and 1½ time in that between the posterior margin of the orbit and the angle of the gill-cover. It is acuminate in form, and contains only 13 rays, 14 being the usual number in normal trout. The second ray is here the longest; the third has a coarse extremity, in which the branches originating from its primary bifurcation again unite; the fourth and fifth rays have also abnormal extremities, which bend in towards each other and nearly fuse. After the sixth ray, which is also slightly affected, the rest are normal in structure and aspect. The pectoral of the left side is also very similarly affected, there being a strange convergence towards one point of the abnormal extremities of the second, third and fourth rays.

The *ventral* fins were in this specimen normal as regards the nature of the rays, but shewed a very remarkable want of symmetry as to size. That of the right side was perfectly normal in size and development, measuring 1⅛ inch in length, and containing the usual number of 9 rays. But the left measured only one inch in length, and in it only 5 rays could be counted.

The *dorsal* fin presented nothing unusual in its appearance, and contained the very common number of 13 rays.

The second or smaller specimen of trout from Lochnamaorachan, measuring eight inches in length, presented the same general aspect as the one just described, but here only the caudal fin was distinctly abnormal. An outline of the hinder part of the fish, slightly reduced in size, is shewn in Pl. XIX., Fig. 3. I counted 39 rays in the caudal, including those at the margins, and of the entire number, the 17 middle ones were long, and came to the hinder border of the fin. Of these long rays, the seven first, counting from above, and the corresponding six, counting from below, were especially shortened, and had their extremities bent downwards and upwards respectively towards the middle line of the fin, their bent extremities shewing, besides a deficiency in the usual fine dichotomisation, a smaller number of transverse joints; the first five of these rays above, and the last four below, being in fact quite simple to their terminations. The four middle rays of the fin, likewise shorter, and somewhat coarser at their extremities than usual, diverged in a nearly straight direction to the posterior margin which was also thicker than in the normal condition. Here also, as in the former specimen, one of these rays near the middle of the fin presented the aspect of being composed of two ordinary rays united at their origins. The *dorsal* presented nothing peculiar, but the *anal* was not so long and pointed in front as usual, though in other points its structure was normal. Of the paired fins, the *ventrals* presented nothing peculiar, but the *pectorals* contained each only 11 instead of 14 rays. The latter were also rather more pointed than is ordinarily the case in *S. Fario.*

In both specimens the teeth were of moderate size. In the smaller specimen, those extending along the body of the vomer could hardly be said to be biserial in arrangement, though alternately pointing to the right and to the left, and though at one point in the middle of the bone one tooth was placed alongside another. But in the larger example the vomerine teeth are on the posterior half of the bone distinctly biserial, presenting an alternating or zig-zag arrangement, although between these and the head of the vomer 4 teeth are seen to follow on each other in one unbroken line. I have already referred to the bluntness of the snout, seen equally in both specimens, and in both the operculum is also rather short, and the sub-operculum more than usually broad. The number of pyloric cœca in the larger example was 39; in the smaller, only 36: in ordinary trout these appendages range in number from 33 to 47. I only dissected the caudal extremity of the vertebral column in the larger specimen, but on making a complete skeleton of the smaller one the number of vertebræ was ascertained to be 59. In neither case was any abnormality to be detected in the posterior extremity of the column, the hard parts of the skeleton with the exception of certain fin-rays being in every respect normal.

Summary. The most salient peculiarity of the Lochnamaorachan trout is the condition of the rays of the caudal fin, which are abnormally shortened, are coarse at their extremities, and deficient as to amount of dichotomisation, and number of transverse joints; besides which they shew also a tendency to coalesce at their terminations. By the convergence downwards of the upper long rays, and upwards of the lower ones, the fin assumes a rounded form instead of presenting the usual broad fan-shaped aspect. As also shewn, the abnormal condition of the extremities of the rays may affect other fins besides the caudal.

As to the physical cause which may have given origin to this singular malformation, and may underlie the most remarkable fact of its perpetuation among all the trout inhabiting that one little lake from which the present specimens were taken, I am unable to offer any well-grounded suggestion; and I refrain also from bestowing any distinct varietal designation on the fish in question, much as that might be justified by the circumstances of their occurrence. Most interesting it would be to ascertain whether this condition is found in trout from other localities and under what circumstances; as would also be an investigation into the history of their development from the ovum. On the occasion of the Lochnamaorachan trout being brought before the British Association by Mr Peach, Dr Grierson of Thornhill in Dumfriesshire mentioned that he had heard of similarly "docked" trout having been taken at Wanlockhead in the same county; but in a letter which I have recently received from that gentleman, he states that he has not yet been able to obtain specimens for examination and comparison with those from Islay. I am also indebted to Mr A. G. More for directing my attention to the following passage from Stoddart's *Art of Angling* (1836), p. 75. "On the Water of Leith we saw a friend capture three successively out of one stream during spring, all of which wanted the tail: this defect was probably occasioned in winter, the water from which they were taken happening to be extremely shallow, and the frosts shortly before somewhat severe." It is now of course hardly possible to ascertain whether the defect in these fish was, or was not, of a nature similar to the stunting of the fin-rays characteristic of the Docked Trout of Islay.

EXPLANATION OF PLATE XIX.

Fig. 1. Outline of Lochnamaorachan Trout, specimen No. 1, reduced in size.

Fig. 2. Dissection of the hard parts of the caudal extremity of the same specimen, enlarged.

Fig. 3. Posterior half of specimen No. 2, slightly reduced in size.

Fig. 4. Dissection of the anal fin of specimen No. 1, natural size.

COMMUNICATION BETWEEN THE EXTERNAL ILIAC AND PORTAL VEINS. By FRANK CHAMPNEYS, B.A., *Brasenose College, Oxford.*

A FEW days since I was struck by the appearance of the veins on the deep surface of the *Rectus Abdominis*, in an aged female subject under dissection at St Bartholomew's Hospital. They were very varicose, as large as an ordinary cedar pencil, and full of blood. They formed a chain from the lower end of the Rectus to the Umbilical fissure of the Liver. On further examination, I found the deep epigastric vein of the right side as large as a goose-quill, ending below, as usual, in the external iliac vein, and running with its artery towards the Umbilicus; near this spot one branch diverged and entered the muscle (no doubt to anastomose with the internal mammary), while the other ran onward and communicated freely opposite the Umbilicus with a pervious umbilical vein, which ran into the left division of the Portal vein. As this trunk passed the Umbilicus, it was joined by several small fibrous-looking bands, some of them still vascular, and all I think formerly veins from the abdominal parietes. Joining with the large trunk, just two inches above the Umbilicus, were two longer cords running from the Umbilicus itself, the lumen of one of which was just distinguishable for a short distance. The *Ductus Venosus* was quite impervious, the liver was much enlarged, pale, and marked with adhesions.

I have been furnished with the following facts. The woman, aged 48, was admitted into the Infirmary of the Holborn Union in December, 1870, suffering from jaundice, clay-coloured stools, short dry cough, and occasional vomiting. About six months afterwards she had slight ascites, which gradually disappeared. The liver was much enlarged, could be felt below the ribs, and the area of dulness was considerably increased. There was no tenderness on pressure or symptom of obstruction. There had been more or less discoloration of the skin with derangement of the liver for 15 months, and she had gradually declined in health.

Supplemental note to pp. 176 and 179 in Vol. VI. of this Journal.

In my paper on the Muscles of the Chimpanzee and Anubis, with their nerves, pp. 176 and 179, I used the expression "*Long Coracoid* of Birds, Monotremes and Reptiles."

I have not heard that this has given rise to any misapprehension, but, as it is better to avoid the possibility of mistake, I wish to state that I used those words in the sense of "prolonged Coracoid," or more exactly still in that of "distal prolongation of the Coracoid," that part namely which exists as bone in Reptiles, Birds and Monotremes, but in animals above them is either aborted or represented in Ligament only.

The expression was a colloquial one, and perhaps as correct as such expressions usually are; the words would have been better printed "*long* Coracoid" (with a small *l*). The interest of this ligamentous band consists of course in the fact of its persistence so high in the Animal Kingdom. The Drill (*Mandrilla leucophæa*) was the highest animal in which it had previously been found.

See Pagenstecher, *Zool. Gart.*, April 1867, p. 129.

FRANK CHAMPNEYS.

A communication between the Portal and Epigastric veins existing as a small branch is said by Luschka (*Anat.* II. 339) to be normal in Man even when adult, and in most Mammals. He describes it under the name of "*Vena parumbilicalis*," which runs, he says, into the Portal vein alongside of the Umbilical vein. It sometimes fuses with that vein, as in Burow's case (*Müller's Archiv*, 1838, p. 44) in a fœtus, as in Hyrtl's case (*Œsterreichische Jahrbücher*, XXVII. 6, quoted by Theile) in an Anencephalous monster, and as in my case quoted above.

In an exaggerated condition it is, I believe, somewhat rare; instances of its enlargement are recorded by Monro (*Elements of Anatomy*, 1825, II. 282, quoted by Henle, *Gefasslehre*, p. 388); by Rokitansky (*Path. Anat.* IV. 373, under the name of "Caput Medusæ"); by Cruveilhier from a case of Pegot's (*Anat. Path.* I. Pl. 6, livraison 16, in a very exaggerated condition, beautifully drawn); Menière (*Arch. Gen. de Méd.* X. 381, 8), who also quotes a similar case of Mannec's which he saw; by Serres (*Arch. Gen. de Méd.* Dec. 1823, p. 633); and Sappey (*Mém. de l'Acad. Roy. de Méd.* XXIII. 270), who, however, is wrong in asserting that this vein *never* joins the Umbilical vein; for it has done so in several cases quoted above, and it certainly did so in mine. In this collection of cases the amount of enlargement varied much, also the age and the absence or presence of communication with the Umbilical vein.

To this head ought probably to be referred a case recorded by Johannes Henricus Schulze (*Dissertatio de vasis umbilicalibus natorum et adultorum.* De Johanne Henrico Schulze *in Disput. Anat. Select.* V. Albertus Haller, Göttingen, MDCCL.); but this may possibly have been a case of regurgitation into a patent umbilical vein—"Mortuam (inquit) secui, atque primo occurrit vena umbilicalis * * * sanguinis copia turgida atque extensa, in quibusdam locis, ubi hæc vena contorquebatur, instar varicum tuberosa. Hepar justam habebat magnitudinem, sed erat album, tuberosum, inæquale, durum et exsangue." The dissection was by Volcherus Coiterus.

Schiff developed artificially a varicose state of this vein by tying the portal vein in Cats (*Canstatt's Jahresbericht*, 1862, p. 127).

From a comparative anatomy point of view this communication has, from the first times of its being observed, been compared with the Epigastric vein of cold-blooded, air-breathing vertebrata, and to this we need not further allude. A large communication between the Epigastric and Umbilical veins is described as normal by Serres and Gratiolet (*Comptes Rendus*, LII. 625), in a Rorqual (Balænoptera), and they infer from the increasing size of the Umbilical vein, as it approaches the Liver, that the blood sets from the systemic to the Portal system; this enlargement, however, may be due to Portal regurgitation. In an account of a Seal (Phoca Vitulina, dissected at Oxford, Sept. 1862, and described in a note-book there), I find that the Umbilical vein was open to within half-an-inch of the Umbilicus, but I cannot ascertain whether it was enlarged.

The development of the Allantois throws the greatest light on this connection between the veins of the anterior abdominal parietes and the Umbilical veins, for the Allantois is not, as formerly stated, an originally hollow budding of the Intestine, but a solid outgrowth from the anterior body-walls (Kölliker, *Entwickelungsgeschichte*, pp. 106 and 420), and these two sets of veins are and must be closely connected. This connection has been described by Rolleston in the Tenrec (*Trans. Zool. Soc.* June, 1863, p. 288); by von Baer in the Pig and Sheep (*Entwickelungsgeschichte*, pp. 214, 247-8, 258); and by Coste in the Sheep (*Hist. Gén. et partic. de Développement*, Pl. iv. Figs. 1 and 2 u). The statement of Sappey that the enlarged communicating vein in some Liver diseases running alongside of the Umbilical vein never joins that vein (p. 270) is, therefore, improbable from a comparative anatomy point of view, besides being an incorrect statement with regard to Man. He even asserts (pp. 272 and 274) that the Umbilical vein receives no branches in its course, which is untrue; in the case I have recorded the small fibrous-looking bands, some of them still vascular, were no doubt the same branches as those described in other animals by Rolleston, Coste, and von Baer. It is true that in some cases (Sappey, 273) the Umbilical vein did coexist without fusion with this other trunk.

The distension of the veins of the abdominal parietes in some Liver diseases has been often observed, as by Sappey (p. 270); Frerichs (*Diseases of Liver*, II. 40), who quotes Sappey's statement above criticised, and in other obstructions by Hasse (*Path. Anat.* Diseases of Organs of Circulation and Respiration, p. 36).

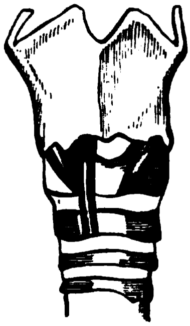
It may be well to remark that, though this communication between the Epigastric and Portal veins is the channel most commonly distended in Liver diseases, several similar ones may exist, as mentioned by Frerichs, and might become varicose; of which two only will be here noted. The first is the connection between the capsular branches of the Portal vein and the Phrenic (*i.e.* superior Phrenic, or "pericardico phrenic," as shewn by the statement of Frerichs, p. 41, note, that the blood of the Phrenic eventually joins the subclavian). These were first made out by Kiernan (*Phil. Trans.* 1833, p. 732), and Frerichs says may always, in newly-formed adhesions of the Liver to the Diaphragm or Abdominal walls, be injected through the Portal vein. The second is the communication, rendered probable by a case of Reynard's (*Journ. Hebd.* 1829, quoted by Hasse, p. 36), between the Phrenic (*i.e.* superior Phrenic) and great Coronary vein, in cases of obliteration of the descending Vena cava, especially with closure of the Vena agygos. This is illustrated by the presence of such a vein in the Rat described by Rolleston (*Forms of Animal Life*, p. 3 and 171 q), running from the fatty tissue in the process of serous membrane which connects the apex of the Pericardium with the Diaphragm, along the Pericardium to end in the left Vena cava descendens.

Lastly, it is dangerous to deny, as Sappey has done, the possibility of connection between any contiguous sets of vessels, and for this point I would refer to some remarks by Turner in *Brit. and For. Med. Ch. Rev.* XXXII. 227.

NOTES OF MYOLOGICAL PECULIARITIES. By S. Messenger Bradley, F.R.C.S., *Lecturer on Comparative Anatomy, Royal School of Medicine and Surgery, Manchester.*

The following myological peculiarities were met with in one of the subjects dissected in the Manchester School during the session 1871—72.

Muscles of the Head and Neck. Both *digastric* muscles had double anterior bellies, the innermost two of opposite sides decussating before passing to their insertion, the right passed over the left belly to be inserted into the under surface of the symphysis menti on the left side, while the left one crossed to the right side.—*Cleido occipitalis.* A very well-developed instance of this curious muscle was met with on the left side. It corresponded very closely with the muscle so-called and figured by Prof. Wood, *Proc. R. S.*, June 18, 1868. A muscular slip, about three-quarters of an inch wide, arose from the tip of the sternum, and joined a broad muscle which sprang from the middle third of the clavicle about two inches higher up; the single resulting muscle passed obliquely upwards to be inserted into the occipital bone. Beneath this muscle, and forming an acute angle with it, a strong, thick muscle, about three-fourths of an inch wide, sprang from the sternal end of the clavicle, and passed to be inserted into the mastoid portion of the temporal bone. The two muscles, the *sterno-cleido occipitalis* and the *cleido-mastoideus*, were perfectly separate throughout their extent. Professor Wood points out that a similar arrangement is met with in "the Marmot, Polecat, Genette, and striped Hyæna, and to a less extent in the Coati."—*Depressor Thyroideæ.* A small muscle, having the above-mentioned action, arose from the lower border of the first Tracheal ring, and passed vertically upwards over the Cricoid cartilage to be inserted into the lower border of the Thyroid cartilage. It was quite distinct from the Crico-Thyroid, of which Professor Wood regards it as a derivative. There was a well-developed *Kerato-cricoideus* on the same side.—*Omo Hyoid.* The Omo Hyoid on the right side had two anterior bellies, each fully equal to an average sized Omo Hyoid.

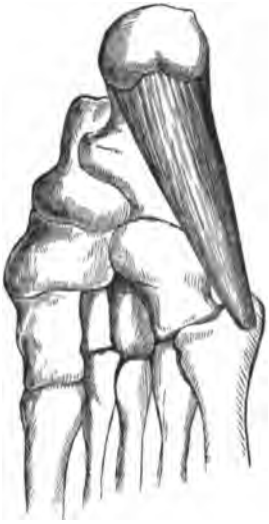


The supernumerary belly sprang from the tip of the great cornu of the Os Hyoides. (The branch of descendens noni which supplied this muscle was joined by a twig from the second cervical nerve.)

Muscles of Trunk. A large well-defined *Rectus Sternalis* was present on one side (the right), attached above to the thoracic fascia, to the manubrium of the Sternum, and to the costal cartilages of the three upper ribs.

Muscles of the upper extremity. The only muscular peculiarity of any importance consisted in the presence of an additional *extensor secundi internodii pollicis.* It sprang from the ulna and the interosseous membrane immediately below the origin of the ordinary muscle, alongside of which it ran to its insertion into the terminal phalange of the thumb. It was present on both sides. All the muscles of the thumb were unusually large and well-developed.

Muscles of the lower extremity.—Abductor ossis metatarsi quinti. In each foot a strong, thick muscle lay immediately beneath the *Flexor accessorius*, taking origin from the under surface of the Calcaneum, reaching from the tuberosities behind to the margin of the groove for the *Peroneus longus* in front, and lapping round the side of the bone was inserted into the base of the metatarsal bone of the little toe. This, which was by far the most interesting muscle met with in the subject, derives importance from the fact that it is a true homologue of a muscle always present in the foot of the Anthropomorpha, though hitherto not recorded, so far as I know, as having been noticed in the foot of man. The evolution argument gains in weight and worth from the record of such cases as these, and it is chiefly as bearing on this question that I have ventured to report these short notes.



NOTE UPON KRYPTOPHANIC ACID. By ARCHIBALD LIVERSIDGE, *Associate of the Royal School of Mines, Scholar of Christ's College, Camb.*

THE following attempts to prepare Kryptophanic acid from urine were made by the author at the suggestion of Dr M. Foster. The processes for its preparation and purification, given by Dr Thudichum in the *Journal of the Chemical Society* for April, 1870, were followed as faithfully as possible; and, as will be seen, whenever any departure was made, which was never great, such deviation is clearly stated. Three distinct attempts were made—one upon a quantity of four gallons of urine, and two upon batches of seven or eight gallons each, and with the like results in each case.

1. *Preparation of the crude Calcium Salt.*

The fresh urine (from Addenbrooke's Hospital) was treated with milk of lime to alkalinity; filtered, and evaporated down. During this concentration the urine acquired an acid reaction, so in the second and third trials the deposit which had formed was filtered off, and the filtrate again rendered alkaline with *clear* lime water, when a pale brown precipitate was thrown down (the precipitate consisted mainly of phosphate and sulphate of lime, together with some carbonate). After removal of the precipitate by filtration the fluid was faintly acidified with acetic acid and further concentrated until crystalline crusts formed.

It was then allowed to stand some time, and the dark brown syrup then filtered off. The syrup was then shaken in a stoppered bottle with five volumes of strong spirit (of about 92 per cent.), when a dark brown, flaky, adhesive precipitate was produced. The spirit poured off from this was highly coloured, a dark brown, so the precipitate was washed with spirit until it no longer gave up colouring matter; the bottle and the precipitate were then warmed and the spirit given out poured away from this crude calcium kryptophanate.

Two of the methods given for its purification were employed, viz. by copper acetate, and by lead acetate.

2. *Purification by Copper Acetate.*

To the aqueous solution of the above crude calcium kryptophanate an excess of copper acetate was added, when a voluminous dirty bluish green precipitate was thrown down, and a dark sap green solution was formed; to the filtrate seven or eight volumes of 92 per cent. spirit were added, when a greenish precipitate ensued: this was filtered off and washed with spirit, and then dissolved in water and decomposed by a current of sulphuretted hydrogen, so as to procure free kryptophanic acid: the copper sulphide was then filtered off and the filtrate evaporated down over the water bath.

3. *Properties of the Kryptophanic Acid thus procured.*

On evaporation down to dryness a dark brown distinctly crystalline mass was obtained, bearing no resemblance to Dr Thudichum's description of kryptophanic acid, viz.:—"a transparent, amorphous, gummy solid mass, almost or entirely colourless."

The brown crystalline mass obtained was partly soluble in water; some white crystals, which did not dissolve, proved on examination to consist of calcium sulphate.

The aqueous extract, when treated with spirit, furnished a precipitate, as is stated of kryptophanic acid; this precipitate was of a dirty grey colour, and as it did not much correspond in appearance with Dr Thudichum's kryptophanic acid, it was at once analyzed and found to consist mainly of potassium phosphate, some calcium sulphate, a little sodium, and a mere trace of organic nitrogenous matter.

It is likewise stated that ether produces a fresh precipitate in the aqueous solution after the one caused by alcohol has been deposited; therefore after the above precipitate had been filtered off, ether was added, when a very slight cloudiness was produced at the line of junction, but it was much too small to examine; it was, however, filtered off and the solution evaporated down on a water bath, when a dark treacly residue, containing a few crystals, thin plates, was left.

When a portion of this residue was heated on platinum foil, it carbonized, gave off an ammoniacal odour, and finally left a white fusible mass containing phosphoric and sulphuric acids, a large quantity of potassium and a trace of sodium; calcium was absent, so that excepting in this last particular its composition much resembled that of the precipitate produced by alcohol in the aqueous solution of the so-called kryptophanic acid.

Another portion of this residue was decolourized by means of animal charcoal, and on evaporation to dryness this likewise contained a certain proportion of nitrogenous organic matter, phosphoric and sulphuric acids, and a large proportion of potassium.

Uric acid was tested for, but found to be absent.

4. *Purification by Lead Acetate.*

An aqueous solution of the crude calcium salt was mixed with an excess of a nearly saturated solution of neutral lead acetate in water, shaken in stoppered bottles and filtered; a dark coloured voluminous precipitate was left on the filter whilst a nearly colourless filtrate passed through.

This filtrate was then mixed with eight or nine volumes of 92 per cent. spirit, when a *whitish* precipitate ensued; this was washed with plenty of spirit, slightly with water and then again with spirit, it was then at once decomposed by sulphuretted hydrogen, the lead sulphide was filtered off and the filtrate evaporated down over water, when a dark brown glossy residue was left, like treacle; this was soluble in water: its aqueous solution, like that of the so-called kryptophanic acid obtained on decomposing the copper salt, yielded a precipitate with alcohol, which precipitate likewise consisted mainly of potassium phosphate, calcium sulphate, &c.; the filtrate also contained the same salts, together with some nitrogenous organic matter of a dark colour.

From the foregoing it will be seen that in every case I obtained precipitates, &c., answering to those described by Dr Thudichum, but that on examination they were found not to be pure definite compounds, but were evidently mixtures of various bodies, and these mostly inorganic, as is especially seen in the precipitate produced by alcohol in the aqueous solution of what should have been Kryptophanic acid.

The percentage compositions of the various salts were not determined because it was useless to make quantitative analyses of obviously impure bodies; but I may state that one specimen of what should have been copper kryptophanate yielded 27·73 per cent. Cu, answering to the 27·50 per cent. of Dr Thudichum's determinations, but that after washing out the soluble impurities with hot water the precipitate was only equal to 23·35 per cent. of Cu.

A small quantity of the copper kryptophanate furnishing these results gave a well-marked potassium spectrum; the products furnished on decomposition by sulphuretted hydrogen have already been detailed.

The numerical data are as follow:—·1280 grm. of the copper kryptophanate yielded on ignition ·0445 grm. residue = 27·73 per cent. Cu, but this after washing was reduced to ·0375 grm. = 23·35 per cent. Cu; therefore there was 27·73 − 23·35 = 4·38 per cent. of soluble impurity still present after ignition, and removed by the washing water.

There may be several explanations of this discrepancy between my results and those of Dr Thudichum, either that the processes for the purification of the different salts are not given in sufficient detail, for the writer was careful to follow the directions furnished with the utmost faithfulness, or that kryptophanic acid does not exist in all samples of human urine, or in but such small quantities that it cannot be well detected; but then Dr Thudichum's remark is hardly reconcilable with this, that it is necessary to make a correction for Kryptophanic acid in determinations of urea—although in his reply to Dr Pircher (in *Centralblatt f. d. Med. Wissens.* 10 Feb., 1872) he says that eight pounds of urine is too small a quantity from which to separate the acid and its salts.

In reference to the decomposition of the copper salt by means of sulphuretted hydrogen, Dr Thudichum says, in the same reply, that it is not wholly decomposed by that gas, but this will hardly affect the presence of such impurities as potassium, phosphoric acid, &c.

It is rather to be regretted that we have not been furnished with any information respecting the precipitates produced on the addition of copper or lead acetate to the concentrated urine and termed basic salts, for the examination of these may throw light upon the matter.

In conclusion I beg to tender my thanks to Dr Foster for the very great help which he has given me by his advice and other assistance throughout the investigation.

Trinity College Physiological Laboratory, Cambridge,
April, 1872.

NOTE ON THE PRESENCE OF TRICHINA SPIRALIS IN THE MUSCLES OF THE RAT. By A. B. STIRLING, *Assistant in the Anatomical Museum, University of Edinburgh.*

ABOUT the middle of February I captured alive a member of a brood of rats, that had infested the cellar of the college-building below the Anatomical Museum. It was about four months old and a male, nearly full grown, was plump, sleek in coat, lively and vicious. After removing the head, and treating it with the intention of making preparations of the internal ear, I proceeded three weeks afterwards to manipulate the head, bisecting it just behind the eyes. On examining the freshly cut muscles of the face and tongue, I observed them to possess an unusual mottled appearance, which, on microscopic examination, was seen to be caused by the presence of multitudes of the Trichina Spiralis enclosed in their characteristic cysts.

The anterior portion of the tongue in front of the frænum was then removed; it weighed exactly five grains, and was firm and compact. From it, by means of my section cutter, I obtained 108 longitudinal sections; on examining 50 of those taken at random, and carefully counting the number of Trichinæ in each, I ascertained the average in each section to be 30, or 3240 in the 108 sections. As, however, the knife may have divided some of the worms, so as to leave a portion in more than one section, we may in order to be within the mark assume that there were not more than ten in each, which would give 1080 in this small portion of the tongue.

The back part of the tongue was next divided in the transverse direction, and 218 sections obtained. On examining 50 of those sections, also taken at random, I found the average number of Trichinæ in each to be 34, or 7412 in all. Assuming, however, as before, that owing to the division of some of the parasites in making the section there were only ten in each slice, this would give 2470 or 3550 in the entire tongue. All the other muscles of the head and face were similarly and quite as extensively affected; for example, one of the oblique muscles of the eye, measuring $\frac{3}{16}$th of an inch in length and $\frac{1}{16}$th in breadth, showed as many as 18 worms in situ.

The cysts were of the usual oblong ovoid form, the length of the cyst being equal to twice its breadth; the outer surface of the walls of the cysts was smooth, and the cysts for two-thirds of their length were in apposition with the muscular fibres which firmly adhered to them.

The inner surface of the walls of the cysts was granular, and irregular, fitting to the coil of the worm, which varied in every individual, suggesting freedom of motion, and change of position within the cyst. A delicate fibrillated process was attached to each of the conical ends of the cysts, passing outwards between the layers of fibres, which were forced aside during the growth of the cysts, and the processes were gradually lost in the intervals between the muscular fibres thus thrust asunder. The walls of the cysts were about equal in thickness to the breadth of a muscular fibre, quite transparent and free from any calcareous deposit.

The muscular fibres were beautifully striated, and showed no trace of fatty or other degeneration, and the fibres in contact with the cysts were as distinctly striated as those at a distance. I greatly regret that in ignorance of the presence of trichinæ in this rat at the time of capture, I destroyed the carcase, and thereby lost the opportunity of observing whether the worms in the free condition occupied the intestinal tract.

The cellar in which the rat was reared is that in which the débris of the bodies used for dissection is kept previous to burial, and it is possible that the rat may have fed upon the flesh of some of the subjects. During the present session, however, and for some four or five years past no trichinized body, so far as was ascertained during the dissection, was admitted into the practical rooms, and there is no direct proof therefore that the animal could have been infected from eating trichinized human flesh. Still, it is well known that trichina cysts are not readily recognised by the naked eye unless they or their contents have reached a certain stage of calcareous degeneration, so that there is always a possibility of overlooking these cysts even in a body subjected to the close scrutiny of the dissecting room.

NOTE ON THE TERMINATION OF THE THORACIC DUCT ON THE RIGHT SIDE.

By M. Watson, M.D., *Demonstrator of Anatomy, University of Edinburgh.*

The entrance of the Thoracic duct into the junction of the subclavian and internal jugular veins of the *right* side seems to be of sufficient rarity to justify the publication of the present case. Cases more or less resembling this have indeed been recorded by Meckel[1], Cruickshank[2], Fleischmann[3], Todd[4], Fyfe[5] and Allen Thomson[6]; but in none of these, however, is there a precise description of the relations of the anomalous duct to the neighbouring structures.

The duct under consideration was found in the course of the dissection of a female subject in the Anatomical Rooms of the University, last year. It commenced in the usual position of the receptaculum chyli, in *front* of the second lumbar vertebra, by the junction of several small branches. It then passed through the aortic opening of the diaphragm, having the aorta on its left, the vena azygos major on its right, these relations remaining the same as high as the intervertebral cartilage, between the tenth and eleventh dorsal vertebræ. Opposite the twelfth dorsal vertebra, it received several small, and a single large branch from the left side of the lumbar portion of the column. Above the cartilage before mentioned, the duct crossed from left to right of the vena azygos, maintaining this position as high as the fifth dorsal vertebra, where it again crossed in front of the vein and spinal column, lying in relation to the posterior surface of the œsophagus, as well as to the third part of the arch of the aorta. It then passed along the left side of the œsophagus, as high as the second dorsal vertebra, when it again crossed the vertebral column obliquely, from left to right, lying between the œsophagus and longus colli muscle, so as to reach the level of the sixth cervical vertebra. Here, arching above the level of the first part of the subclavian artery, it turned downward and outward to open into the right internal jugular vein previous to its junction with the subclavian.

When in the cervical region, it rested successively on the longus colli muscle, the vertebral vein, the origin of the inferior thyroid artery, the anterior scalene muscle and the phrenic nerve, having in front of it the œsophagus, trachea, vagus, and recurrent nerves of the right side. A well-developed valve defended the entrance into the jugular vein. Although a careful dissection was made on the left side, no lymphatic trunk could be discovered there. With reference to the vascular trunks, no deviation of any importance was observed, except the somewhat higher position than usual of the left innominate vein, which, in passing from left to right to unite with its fellow of the opposite side, lay altogether above the upper border of the sternum, and consequently in the region of the neck.

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[1] *Diss. Epist. ad Haller.*
[2] *Anatomy of the Absorbing Vessels.*
[3] *Leichen öffnungen.*
[4] *Cycl. of Anat. and Phys.* III.
[5] *A Compendium of the Anatomy of the Human Body.*
[6] *Quain's Anatomy*, 7th edition.

If now we compare the various cases on record, we find that those of Fleischmann, Todd and Allen Thomson, were accompanied by certain vascular peculiarities; in the two first the right subclavian came off from the trunk of the aorta, while in the last there was a right aortic arch. No such vascular anomalies are recorded in the cases of the other authors.

Cruickshank states that "sometimes the thoracic duct is inserted into the right subclavian vein, and then the trunk of the absorbents of the left side in every respect resembles the ordinary appearance of that of the right side." Now, we have seen that there was no lymphatic duct of the left side in the present case, and consequently must conclude that a single thoracic duct received the absorbents of the whole body. This case, therefore, resembles more closely that recorded by Fyfe than any of the others, differing only in this, that whilst in his case the duct crossed *in front* of the large vessels at the root of the neck, in the one under consideration it passed *behind* these. With the exception of trifling differences of relation entailed by this, the two are in all essential particulars similar cases.

NOTE OF AN ABNORMALITY IN THE HUMAN DENTAL SERIES. By JOHN C. GALTON, M.A., F.L.S.

THE following interesting and somewhat rare abnormality in the human dental series occurred in a young man, of about one-and-twenty years, who had died of variola in the Allgemeine Krankenhaus in Vienna.

Incisors regular and of normal shape. Right canine crowded out by first premolar and appearing through the gum just above the supplanting tooth. Left canine in normal position. Immediately behind the two median incisors had been two supernumerary teeth, reminding one of the posterior pair of small incisors in the *Leporidæ* among Rodentia. The right one had been extracted, a deep single alveolus being left to view; while the other, which resembled in shape the two canines, remained *in situ*.

Nothing anomalous in teeth of lower jaw, or in remaining teeth in upper jaw. The wisdom teeth in the latter had been already cut.

JOHN C. GALTON, M.A., F.L.S.

Vienna, Feb. 5, 1872.

Since the foregoing note was written, I have had opportunity of looking up the literature of the subject. This, however, is somewhat meagre, and is mostly to be found in the pages of the *Transactions of the Odontological Society*. In Vol. II. 1st series of the above publication, Mr J. N. Manton, in "A statistical account of 1500 permanent teeth removed, from various causes, at the Middlesex Hospital, between Oct. 1856 and Dec. 1857," mentions (p. 28) that six supernumerary teeth had been extracted during this period. This distribution was as follows :

1. Man, æt. 25, two such teeth, situated behind upper central incisors.

2. Girl, æt. 16, two perfectly formed supernumerary lateral incisors, placed behind normal lateral incisors, upper jaw.

3. Girl, æt. 12, supernumerary tooth behind left lateral incisor, lower jaw.

4. Girl, æt. 17, supernumerary tooth between central incisors, upper jaw.

5. Girl, æt. 16, supernumerary tooth between lateral incisor and canine, left side, upper jaw.

[This makes seven in total and not six as above stated.]

Mr Tomes (*op. cit.* Vol. III. 1st series, p. 282) read a case before the Society, reported by Mr Tellander of Stockholm, describing an enlargement of the right maxilla containing—not reckoning lost teeth—28 teeth or cusps attached and unattached. On this side of the jaw the canine, both premolars, and the first molar were absent. As the temporary teeth had not attracted attention, it may be presumed that they were normal in number and arrangement. After the evacuation of the cyst containing the rudimentary teeth, a supernumerary tooth (exact site not mentioned) and a bicuspid made their appearance in the same spot as the swelling.

Mr S. Longhurst, in a paper entitled "Lateral Abnormalities," (*op. cit.* 1st series, Vol. V.) remarks thus (p. 90) : "in three-fourths of the cases of supernumerary teeth I have seen or heard of, I have noticed that the intruder has generally presented itself in this locality, namely, before, between, or behind the *centrals* and *canines*. And, lastly, that supernumerary teeth, although occasionally simulating bicuspids and dwarfed molars, yet, as a rule, more closely resemble, in size, position and figure, mal-formed laterals, than any other class of teeth."

Prof. Owen, in his *Odontography* (Vol. I. p. 410) mentions that Cuvier has figured the jaw of a young Rabbit, before the deciduous hinder incisors were shed, in which six incisors were present in the upper jaw. This Prof. Owen regards as "interesting both as a transitory manifestation of the unusual number of incisor teeth in the mammalian series, and as it elucidates the disputed nature of the great anterior scalpriform teeth." (See also Pl. 104, fig. 5, Atlas of "Odontography.")

All these cases, together with the one just described by me, seem to point pretty clearly to the fact that the seat of election of such supernumerary teeth is the intermaxillary bone. The next question is, Is there anything either in the structure, shape, or development of this bone, which would favour such excentricities of growth?

There may yet be some who will see in this, as did Prof. Owen in the case of the Rabbit, a struggle, often very ineffectual it is true, after "adherence to type;" but such explanation will not satisfy all inquirers.

When it is remembered that the existence of a tooth, seeing that it is no periosteal product, depends upon the formative activity of the gum—of which the sharks, perhaps, afford the best and most striking instance—and not upon the subjacent bone in which it is finally implanted, it will appear almost useless to look for any solution of the question in the history and peculiarities of development of each tooth-bearing bone, the more so when it is borne in mind that certain bones which are destitute of teeth in some vertebrata, e. g. the vomer and basi-occipital, carry teeth in others.

It cannot, however, be overlooked that by far the majority of cases of supernumerary teeth occur in the upper jaw, and further, that no case, as far as I am aware, has been recorded in which they have been associated with teeth which have had no milk precursors, i.e. true molars.

It is to be hoped, therefore, that, for want of a better reason, it will not be deemed unphilosophical to regard the question merely as one of opportunity—I mean that, with regard solely to the upper and lower jaws, the former, from the palatal expansions of its maxillary and intermaxillary factors, offers a wider field for the formative excentricities of the gum than the latter with its narrow-edged bony hoop; while, as regards the true molars and those teeth which have had a "milk" ancestry, the formative tendency of that part of the gum which gives rise to the former seems less apt to run riot—why, I can offer no suggestion—than that which, by a process of gemmation which, as can readily be imagined, is capable of becoming carried to an excess, normally provides two, but only two, generations of teeth.

J. C. G.

REVIEWS AND NOTICES OF BOOKS.

Handbuch der Lehre von den Geweben des Menschen und der Thiere.—Herausgegeben von S. STRICKER, V. Lieferung, Leipzig, 1872.—This part completes the issue of the very excellent Manual of Histology, which has been prepared under the editorial superintendence of Prof. Stricker. It contains elaborate articles on the Organs of Sense, in which the Retina is described by Max Schultze, the Membranous Labyrinth by Rüdinger, the Cochlea by Waldeyer, the Lymphatics of the Eye-Ball by Schwalbe, the Cornea by Rollett, the Lens by Babuchin. In another Chapter the structure of the uterus, Placenta, and Fallopian tube is described, and Stricker himself contributes an article on the development of the simple Tissues.

Die Lymphgefässe der Fascien und Sehnen. Von C. LUDWIG und F. SCHWEIGGER-SEIDEL, Leipzig, 1872.—This beautifully illustrated Monograph by the eminent Leipzig physiologists has been published since the death of Prof. Schweigger-Seidel, by his colleague Prof. Ludwig. It comprises an elaborate enquiry into the distribution and arrangement of the lymph-vessels in fasciæ and tendons—structures in which it is usually supposed that these vessels are either altogether absent, or, if present, only very sparingly distributed. Their observations have been principally conducted on the aponeurosis situated superficial to the knee-joint of the dog, where the fascia lata is in relation to the tendons of the mm. rectus femoris, biceps and vasti, and on the tendo Achillis of the calf. They have succeeded in filling with a Berlin-blue injection a minute system of capillaries both in the aponeurosis and in the tendons themselves. These capillaries were injected, not from the blood-vessels, but by sticking the point of the syringe into the tissue itself, and then carefully pressing the injection onwards. A minute network was then displayed, which consisted in part of fine polygonal meshes and in part of longitudinal vessels which ran parallel to the bundles of the tendons. These vessels were not only situated in the aponeurosis and in relation to the surface of the tendons, but were also found in the substance of the latter; for when transverse sections were made through the tendons, the injected vessels could be distinctly seen cut across, and lying in the looser connective tissue which separates the constituent bundles of a tendon from each other. In the substance of the tendon, however, these vessels were less numerous than on the surface; and they anastomosed the less frequently the further they lay from the surface. The Authors state that the injection was not situated in mere spaces between the bundles of the connective tissue, but was contained in lymph-vessels possessing distinct walls, in which nuclei could be seen on the addition of carmine, and in which after the addition of nitrate of silver the characteristic markings of the lymph-capillaries were displayed.

Handbuch der systematischen Anatomie des Menschen, von Dr J. HENLE, Band III., Abtheilung II., Erste Lieferung. Braunschweig, 1871.—In this part of his great work on Human Anatomy, Henle has given an elaborate description not only of the naked eye relations and appearances of the Human Brain and Spinal Cord, but of their microscopic structure.

No other text-book contains so clear and comprehensive a statement of the complex structural relations of these important organs; for in his description he has not only made full use of the published observations of other anatomists, but has embodied a large amount of new work of his own. The part is illustrated by 224 admirably executed woodcuts, and forms in itself a Monograph of great value to all engaged in the study of the Anatomy and Physiology of the Nervous System.

Beiträge zur Anatomie des Menschen mit Beziehung auf Bewegung von P. J. W. HENKE. Heft I., Leipzig, 1872.—Professor Henke of Rostock has for some years past directed his attention to the study of the mechanism of the human body, more especially the structure and movements of the Joints, and has published in Henle and Pfeuffer's *Zeitschrift* and elsewhere papers on these subjects. The present publication is the first part of a new series of contributions to Human Anatomy, with especial reference to the movements performed by the different organs and the arrangement of the structures concerned in those movements. It comprises an account of the distribution of the connective tissue in the neck, thorax, abdomen and pelvis, and of the topographical relations of the Heart and Pharynx. We cannot commend the style and mode of execution of the lithographic plates, which are rude and coarse to a degree. Surely in Germany, where the illustration of scientific books by lithography has reached so high a degree of perfection, the author might find a more competent draughtsman to execute his plates.

A Monograph of the British Graptolitidæ. By H. ALLEYNE NICHOLSON, Edinburgh, 1872.—In this Monograph Prof. Nicholson proposes to give a systematic description of the curious and difficult group of fossils named Graptolites. Part I., as yet, only has been published, and in it the author gives an historical and bibliographical sketch of these fossils, a description of their general form, and general and special morphology, of the nature and functions of the base, of their mode of production, of their systematic position and affinities, of their geological distribution, and of their generic distinctions. He regards these fossils as constituting a special group of the Hydrozoa, not represented by any living forms, but with peculiarities sufficiently numerous and distinctive to entitle them to the rank of a distinct sub-class. The part is well illustrated with 74 woodcuts, and the Monograph will, if completed in the same spirit which has prompted the preparation of this first instalment, be a valuable contribution to British Palæontology.

REPORT ON THE PROGRESS OF ANATOMY.

BY PROFESSOR TURNER[1].

OSSEOUS SYSTEM.—Albert Kölliker contributes a memoir on the DISTRIBUTION AND SIGNIFICATION OF POLYNUCLEATED CELLS IN BONES AND TEETH (*Verh. der Würzburg phys. med. Gesellsch.* March 2, 1872). Polynucleated cells (*Myelo-plaxés*) are found wherever in the course of development bony or dental tissue undergoes absorption. During this absorption the tissue presents on the surface a peculiar system of small cavities, the so-named lacunæ of Howship, each of which contains, as a rule, a single colossal cell (*Riesenzelle*), though two or more may be met with. These cells do not arise through a transformation of the cells of the affected hard parts, but through an especial conversion of the formative cells (osteo-blasts) of the osseous tissue, and are the organs which cause the absorption of the tissue, wherefore the author names them osteo-klasts (bone-destroyers). Howship's spaces and colossal cells occur in the interior of bones close to the margin of ossification of ossifying cartilage, on the walls of the larger medullary spaces of developed bones, on the walls of such cavities as the cranial air-sinuses during their formation. On the outer surface of bones as long as they are growing a destruction of the tissue through lacunæ and *myelo-plaxés* occurs, and in the milk-teeth such cells are found in the lacunæ on the surfaces where absorption is going on. The development of the bones and their typical configuration is a product of the processes of formation taking place by the agency of the osteo-blasts, and of the absorption of the bony tissue through the action of the osteo-klasts.——Wenzel Gruber communicates to *Reichert u. Du Bois Reymond's Archiv*, Nov. 1871, variations in the OS NAVICULARE TARSI. In one case the right bone had its external lateral surface truncated: in another, the left bone had the tuberosity developed into a well-formed process: in another, the right bone had an epiphysis on the tuberosity instead of the process, and in a left bone a separate ossicle articulated with the tuberosity. In the same *Archiv* he figures and describes a PROCESSUS DELTOIDEUS on the clavicle at the deltoid attachment, and a CONGENITAL HOLE at the inferior angle of the RIGHT SCAPULA. Gruber also in *Bull. de l'Acad. imp. de St Pétersb.*, Nov. 1870, describes additional cases of the occurrence of the styloid process of the third metacarpal as a SUPERNUMERARY CARPAL BONE. In the *Memoirs* of the *St Petersburgh Academy*, 1871, he makes some general observations on the TARSUS and describes, as CALCANEUS SECUNDARIUS, a new secondary tarsal bone, and in the same volume he publishes a memoir on the FIRST INTER-METATARSAL JOINT in the human foot, with comparative anatomical observations.——J. B. Perrin notes (*Med. Times and Gaz.*, Jan. 13, 1872) the co-existence of EPI-CONDYLOID and

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[1] To assist in making this Report more complete, Professor Turner will be glad to receive separate copies of original memoirs and other contributions to Anatomy.

EPITROCHLEAR FORAMINA in the left arm of an aged female subject, and a case in which a high origin of the pronator teres was perforated by the median nerve and ulnar artery. He notes also the presence or absence of these foramina in the skeletons of many mammals, and states that the epi-condyloid foramen is of rare occurrence in the human subject in this country. This latter statement is not in accordance with the experience and the recorded observations of anatomists in Edinburgh. Since Robert Knox first pointed out in 1840 the morphological signification of this process, it has been repeatedly met with and cases described by H. Lonsdale (*Life of Knox*, p. 252), J. Struthers (*Edinb. Med. Journ.*, 1848, and *Brit. and For. Med. Chi. Rev.*, 1854), and the Reporter (*Trans. Roy. Soc., Edinb.*, 1864, P.R.S. Ed. 1869, and *Report Brit. Assoc.*, 1865). And as the occurrence of this foramen in man does not seem to have attracted much attention in the London dissecting rooms, the Reporter may mention here that he has in his collection 21 specimens of EPI-CONDYLOID FORAMINA from 16 subjects of both sexes, and of all ages, from infancy to advanced life, dissected in the Practical Anatomy Rooms of the University of Edinburgh. Experience has shown that the epi-condyloid process in man never reaches, as in the cats, the condyle itself, but that the boundary of the foramen is completed by fibrous membrane. The length of the process also varies in different individuals. In the best marked specimen in the Reporter's collection it is triangular in shape, 0·8 inch long, and 0·8 inch broad at its base, whilst in others it is only a faint tubercle, and in these latter cases fibrous membrane forms almost entirely the outer boundary of the foramen. In an adult female, dissected in Feb. 1871, no bony process existed, but a band of fibrous membrane arose from the shaft of each humerus 3 inches above the internal condyloid eminence, as a distinct offshoot from the anterior part of the internal intermuscular septum, and passed downwards to be attached below to the eminence, so as to form an epi-condyloid foramen, through which both brachial artery and median nerve proceeded. The brachialis anticus arose from the upper end of this band and the pronator teres from its lower end. In the left arm a nodule of bone, not continuous with the humerus, was developed in the substance of the fibrous band. This case is of interest in connection with the development of the epi-condyloid process. In the cat for example, and presumably in all mammals, where the boundary of the epi-condyloid foramen is entirely osseous, the process is developed in cartilage continuous with the primordial cartilaginous shaft of the humerus, as the Reporter saw in an embryo kitten, the humerus of which was only 0·25 in. in length, so that in these animals the process is fundamentally a cartilage bone. In man, however, the lower part of the process is at all times fibrous, and, as the above case shows, it may even be fibrous in its entire extent, or a bony nodule may be developed in the fibrous band quite independent of the humerus. Hence it may be regarded as a membrane rather than a cartilage-bone. The Reporter may repeat here, what he has indeed already published, that at least one per cent. of the bodies dissected in Edinburgh possess the epi-condyloid foramen in the humerus.——

J. B. Perrin records in *Nature*, July 6, 1871, observations on the occurrence of an ADDITIONAL TRUE RIB IN MAN. In one specimen the right 7th and 8th costal cartilages blended together about ¼ inch from meso-sternum; the left 8th cartilage was free at its sternal end and arrested about 1½ inch from meso-sternum. In another the 8th right cartilage was free at its sternal end and arrested within 1 inch of the sternum: on the left side the arrest was 2½ inches from the sternum. In another a complete 8th right sternal rib articulated with the Xiphi-sternum. In a negro, also a complete 8th right sternal rib was seen.——T. Zaaijer discusses (*Nederland. Tijdsch. voor Geneeskunde*, 1871) the INTERNAL CONSTRUCTION OF THE BONES, and illustrates his observations by two photo-lithographic plates.——H. G. Seely, in *Ann. Nat. Hist.*, April, 1872, publishes the 1st part of a memoir on the ORIGIN OF THE VERTEBRATE SKELETON.——George Busk gives, as an appendix to a paper by W. Boyd Dawkins (*Journ. Ethnol. Soc.*, London, Jan. 1871), on the contents of a refuse heap, a tumulus and two bone-caves in Denbighshire, an account of the skeletons of some PLATYCNEMIC MEN. The crania, thigh-bones and tibiæ are especially described, and, from the compressed or flattened form of the tibiæ, the conclusion is drawn that the people of that period were of the platycnemic type—a type which was first observed in the human remains procured by Captain Brome from the Genista cave, Gibraltar.——Rudolf Virchow (*German Quarterly Magazine*, Nov., 1871) discusses in a popular manner the CRANIAL AFFINITIES OF MAN AND APES.——Paul Gervais figures in the new French *Journal de Zoologie*, 1872, the cranium of Descartes, and reproduces a letter from Berzelius to Cuvier on the subject.—In a contribution to the DEVELOPMENT OF BONE in *Robin's Jour. de l'Anat. et de la Phys.*, part I., 1872, A. Dubrueil points out that the volume of the Haversian canals varies in direct ratio to the age of the individual, but their number in inverse ratio.

NERVOUS SYSTEM.—Chrschtschonovitsch investigates (*Sitzb. der k. Akad. der Wissen.* Wien, 1871), the TERMINATION OF THE NERVES IN THE VAGINAL MUCOUS MEMBRANE, and enquires into their relation to the smooth muscles, to the blood-vessels, and to the surface epithelium. The vaginal mucous membrane is very rich in branched cells, which lie close together in the most superficial layers. A fine branching network of non-medullated nerve-fibres lies in the more superficial part of the membrane, which is associated with the blood-vessels, and sends loops around them. A sub-epithelial network of non-medullated nerve-fibres also exists, which gives off delicate twigs into the deeper layer of the epithelium, like what Langerhans has described in the *rete Malpighii* (Report III. 452). In the bitch single fibres have been traced into the most superficial layer of flattened epithelial cells, where they swell out at their ends. The fibres found amongst the epithelium also possess granular varicosities. No connection was traced between the non-medullated fibres and the processes of the branched cells. The bundles of smooth muscular fibres are surrounded by a close network of non-medullated fibres, from which delicate twigs with granular varicosities pass between the individual muscle-cells, and form once more a net-like arrangement; but he could not trace any connection between the nerves and the nuclei of the muscle-cells.——E. Klein contributes (*Quart. Journ. Mic. Science*, Oct., 1871, Jan. April, 1872) a memoir on the PERIPHERAL DISTRIBUTION OF NON-MEDULLATED NERVE FIBRES. His observations on the nerves of the cornea are, as regards the distribution of the more deeply-placed plexus of broader nerves, and the sub-epithelial network of fine nerve fibres, in the main confirmative of those of Cohnheim. His description of the distribution of the nerves in the epithelium covering the front of the cornea is very minute. He recognises both a deep and a superficial intra-epithelial network, the latter being distinguished from the former by the greater density of the network, the greater thickness of the fibres, and by the presence not only of small varicosities, but of larger swellings at the junction of two filaments. He also investigates the distribution of the non-medullated nerves in the nictitating membrane of the frog, in the peritoneum, in the tongue of the frog, and in the ciliated duct in the tail of the rabbit. The general conclusion to which he comes is, that the coarser nucleated non-medullated nerve-fibres which accompany an artery give origin to numerous finer nucleated nerve fibres, which form a dense perivascular plexus. From this plexus still finer fibrillæ, without nuclei, arise, which can be traced into the wall of the vessel itself, but no connection could be traced between these fibrillæ and the nuclei in the vascular wall. Intra-epithelial networks formed of fine fibres also occur. In the glands of the nictitating membrane filaments pierce the membrana propria, pass between the gland-cells, bifurcate, and unite with each other in a retiform manner.——E. Elin communicates (*Schultze's Archiv*, VII. 382) a paper on the TERMINATION OF THE NERVES IN THE BUCCAL MUCOUS MEMBRANE. He describes a network of non-medullated fibres in the superficial layers of the mucosa, from which minute fibres proceed into the papillæ, and thence into the epithelial investment of the papillæ; these fibres situated in the epithelium possess small granular varicosities, and they lie almost perpendicular to the free surface.——Lionel Beale gives an account (*Month. Mic. Journ.*, Jan. Feb., 1872) of the RELATION OF THE NERVES TO THE CAPILLARIES AND TO THE PIGMENT AND OTHER ELEMENTARY CELLS. He states that he has traced fine fibres to the smallest capillaries of many tissues from ganglia, from sensitive and motor nerve-trunks, from the peripheral ramifications both of sensitive and motor nerves, and that in some localities they are intimately related to the ultimate ramifications of some of the nerves of special sense. His observations have led him to the general inference that in no instance is there a continuity of substance between a nerve and the tissue in connection with which it is distributed.——Wenzel Gruber has seen (*Virchow's Archiv*, LIV. 190) two cases in which the FACIAL NERVE passed through the parotid gland between the temporal artery and vein; and one in which the DORSAL BRANCH OF THE ULNAR NERVE supplied the skin of the fourth and fifth fingers on their dorsal surfaces, the radial the other digits.——Carlo Giacomini (*Giorn. della*

Accad. de Med. di Torino, 1872) records a case of ABSENCE OF THE DORSAL CUTANEOUS BRANCH OF THE RIGHT ULNAR NERVE, the whole of the digits receiving their dorsal cutaneous nerves from the radial.—— The paper by W. Turner in this *Journal,* Nov. 1871, on VARIATIONS IN THE DISTRIBUTION OF THE NERVES may also be referred to.

VASCULAR SYSTEM.—Wenzel Gruber records (*Reichert u. du Bois Reymond's Archiv,* 1871) a case of SUBDIVISION OF THE RIGHT ULNAR ARTERY into a superficial and a deep branch, and in *Bull. de l'Acad. des Sc. de St Pétersb.,* May, 1870, a case in which the DORSAL PART OF THE RADIAL ARTERY was subcutaneous in the fore-arm and hand, and another case, in which the BRACHIAL ARTERY was united opposite the elbow-joint by a TRANSVERSE BRANCH to the ulnar artery, which had a high origin in the upper arm.——In *Virchow's Archiv,* LIV. 190, various ANOMALIES IN THE VENOUS SYSTEM are described by W. Gruber; in one the inferior cava was formed by the junction of three trunks, viz. the right and left external iliacs, and a common iliac formed by the junction of the right and left internal iliac veins; in another the three trunks which formed the inferior cava were the right common iliac, the left external and left internal iliac vein; the left external and internal iliacs were connected by two intermediate branches; cases of the passage of the left innominate vein through the thymus, and of anomalies in the anterior jugular, external jugular, and lesser saphenous vein, are also recorded. In *Bull. de l'Acad. des Sc. de St Pétersb.,* March, 1871, Gruber gives an account of *varieties* in the course and arrangement *of the popliteal vein.*——S. Soboroff communicates (*Virchow's Archiv,* LIV.) a paper on the STRUCTURE OF NORMAL AND DILATED VEINS.——Julius Arnold publishes (*Virchow's Archiv,* LIII. and LIV.) a series of researches on the DEVELOPMENT OF THE BLOOD-CAPILLARIES. His observations are conducted during the regeneration of the tail of the tadpole, during the formation of vessels in the inflamed cornea, and in the vitreous body in the embryo. Extremely delicate threads of protoplasm sprout out from the walls of pre-existing capillaries; these threads increase in length and thickness, and join similar threads sprouting from another part of the wall of the same capillary, or from adjacent capillaries; loops or arches of protoplasmic threads are thus formed, and as the threads increase in thickness, they at the same time become hollowed out in their interior by solution of the central protoplasm, and are converted into delicate tubular vessels, so that a capillary network is produced; these observations agree with those made by Stricker, who showed that the blood-capillaries arise as solid threads, which subsequently become hollowed out into tubes. Nuclei appear sooner or later in the protoplasmic wall of these capillaries: the granular condition of the wall disappears later on, so that it assumes a more homogeneous appearance. In the vessels of the inflamed cornea Arnold satisfied himself that the new-formed capillaries possess the appearance of an endothelium, such as is seen in normal capillaries, and that this endothelium is formed by a conversion of the wall of nucleated protoplasm into flattened, polygonal, nucleated endothelial cells closely connected together by their edges. A great number of capillaries possess not only an endothelial wall, but an investing tunica adventitia.——E. Klein relates (*Sitzb. der Akad. der Wissensch.* Vienna, 9th Feb., 1871) his observations on the DEVELOPMENT OF THE EARLIEST BLOOD-VESSELS AND BLOOD-CORPUSCLES in the middle germinal layer of the embryo chick. After giving an analysis of the work done by others in the same field of enquiry he then proceeds to relate his own observations, and concludes by stating that all the blood-vessels of the area pellucida and area vasculosa pass into the *Darmfaserplatte*, and that the vessels belonging to the deeper layer of the area vasculosa, as well as the first vessels of the area pellucida, possess, in addition to an endothelium bounding the lumen of the vessel, a wall consisting of a cell network, which is not the case in the sinus terminalis, and in the vessels belonging to the superficial layer of the *Darmfaserplatte* of the area vasculosa. The former vessels are arteries, the latter veins.——Richard Norris contributes (*Trans. St Andrew's Medical Graduates' Association*, 1871) a memoir on the EXTRUSION OF THE MORPHOLOGICAL ELEMENTS OF THE BLOOD, in which he contends that the blood-corpuscles are among themselves amenable to the same physical laws as soap-bubbles, and that they do not unite either with each other or with the capillary wall unless their normal osmotic relations are disturbed, the exosmotic current setting in excessively, when their external surfaces become coated with content matter, and they become instantly attractive of the capillary wall. Having cohered to the wall the ease of transmission of the corpuscles through it is simply a question of the extent to which it possesses the "principle of flow," under the pressure to which it is subjected. Having effected cohesion, it becomes easier for the capillary wall to give way, and glide over the corpuscles than to be distended by them, the content matter of the corpuscle present on its surface through disturbance of the osmotic relations being the material through the medium of which the cohesion is effected.——In *Quart. Journ. Mic. Sc.*, Oct., 1871, E. Ray Lankester records observations and experiments on the RED BLOOD-CORPUSCLE, chiefly with regard to the action of gases and vapours; in the January number, 1872, George Gulliver states that the RED BLOOD-CORPUSCLES OF LAMNA CORNUBICA have a mean long diameter of $\frac{1}{923}$rd of inch, and a short diameter of $\frac{1}{1500}$th; and in April, 1872, J. Braxton Hicks notes some observations on PATHOLOGICAL CHANGES IN THE BLOOD-CORPUSCLES, which he regards as confirming the belief that two constituent parts exist, both of which are in a plastic state; that they are composed of material in a "formative" condition, and that no proper cell-wall exists.

UTERUS, PLACENTA, AND MEMBRANES.—Carl Friedländer relates his researches on the uterus (*pamphlet, Leipzig*, 1870). He describes the structure of the decidua in the pregnant human uterus. He subdivides both the vera and serotina into two layers; an inner cell-layer intermingled with the chorionic villi, the cells of which are elongated or rounded, and colossal in size; and a glandular layer, which contains hollow spaces clothed with an epithelium, the cells of which are partly flattened, partly cylindrical. He considers these spaces to be modified utricular glands. He points out that a large number of the uterine sinuses in the placental area are plugged up from the eighth month, owing to coagulation and organisation of the blood-clot. He describes goblet cells (*Becher-zellen*) in connection with the epithelial lining of the cervix; the glands of the cervix in children are semi-globular depressions, whilst in adults they are long, and often branched cylindrical tubes. He shows that the simple glands of the bitch's uterus described by Sharpey do not exist in the quiescent state, but when the animal is in heat, and the mucous membrane swollen and tinged with blood, then simple glands are met with along with the proper utricular glands.——In a valuable memoir on the STRUCTURE AND FUNCTION OF THE PLACENTA, by G. B. Ercolani, communicated to the *Academy of Sciences*, Bologna, in 1868—a French translation of which, by Bruch and Andreini, was published at Algiers in 1869—the author affirms that the crypts in the surface of the mucous membrane of the pregnant uterus, which receive the villi of the chorion, are not the dilated mouths of the utricular glands, but are new-formed gland follicles produced by the transformation and folding of the uterine mucous membrane in the interspaces between the uterine glands, and he conceives that the nutrition of the fœtus is effected by the secretion of these follicles, and not by an interchange of materials between the fœtal and maternal vascular systems. Ercolani's views have been criticized by the Reporter in his Memoir on the Gravid Uterus, and on the Arrangement of the Fœtal membranes in the Cetacea (*Trans. Roy. Soc. Edinb.*, 1871), in which memoir he shows that the placental affinities of the cetacean approach more closely to the mare than to any other mammal, the placentation of which has been accurately studied. Both animals are uniparous, and possess an elongated chorion, over the entire surface of which, with the exception of three limited areas (two polar and one intermediate), well-defined villi are "diffused." In both the amnion is studded with small corpuscles, and the umbilical vesicle disappears some time before birth. In both the allantois persists as a large sac, but whilst it preponderates over the amnion in the soliped, it possesses a relatively smaller area in the cetacean. In both the highly vascular free surface of the uterine mucous membrane is crowded with crypts for the reception of the villi of the chorion, and in both the utricular glands are well developed; but in the mare the glands ascend with a comparatively straight stem almost vertically to the crypt-layer; whilst in the cetacean they are so tortuous as to be followed with considerable difficulty to their termination. A second memoir on the FORMATION OF THE GLANDULAR PORTION OF THE PLACENTA, by Ercolani, has now appeared in *Mém. dell' Accad. delle Scienze di Bologna*, 1870. He examines the diffused placenta in solipeds; the multiple placenta in ruminants (cow); the single placenta in carnivora (cat); cheiroptera, rodentia (rabbit, hare, guinea-pig, mouse), insectivora (mole), quadrumana (cercopithecus sabaeus) and man. He ascribes the fixing of the ovum in the uterus to the tumefaction of the uterine mucous membrane, which circumscribes and incarcerates the ovum. This tumefaction in the cat consists not only of a turgescence and increase in volume of pre-existing parts, but in the assumption by the mucous membrane of a folliculated character. The borders of the follicles become elevated into large folds, which form festoons. When the mucous membrane is lax, the tumefaction is due to an enlargement of the utricular glands, to an increased afflux of blood, to dilatation of pre-existing, and formation of new vessels, and to hypertrophy of the connective tissue corpuscles. When as in woman the epithelium is closely connected to the uterine connective tissue, the tumefaction is due to the same factors, though the proliferation of the strata of sub-epithelial connective tissue is the most important. In the diffused form of placenta (mare, sow), the utricular glands augment in size, and continue to pour out fluid between the uterine surface and the chorion, and last during the period of pregnancy, without undergoing any notable alteration. He finds no utricular glands in the cotyledons of the cow, because he believes that their apertures of exit are closed by the development of the cotyledonary substance. In the doe, near the cotyledons, the glands, after undergoing a certain enlargement, lose their epithelium, or at least it assumes an atrophied appearance. In carnivora the utricular glands undergo at first a remarkable dilatation in the region of placental formation, and remain altered in shape up to the end of pregnancy; in the act of parturition a part remains attached to the placenta, another part to the uterus, the uterine part subsequent to parturition being destroyed by fatty degeneration. He adheres to his original view that the follicles into which the villi of the chorion are received are of new formation, and that the villi do not penetrate into the utricular glands. He holds that a cellular element of new formation, a decidua serotina, is produced in all placental mammals, whatever may be the configuration of the placenta. On this point the Reporter may refer to the observations of Richard Owen (*Comp. Anat. Verteb.*, III. 737), "wherever there is placenta, there is decidua; the special and temporary work of development providing capillary superficies, whether on the part of the mother or fœtus being ended, they go; they may not be thrown off together, and the maternal decidua may not be shed all at once, but in successive shreds or tags;" and to his own observations on the placentation of the cetacea in the memoir already referred to, p. 496, Ercolani holds with Kölliker that the cells of the serotina must not be regarded as epithelial, and further that they arise by proliferation of the sub-epithelial connective tissue of the mucous membrane, or by a direct transformation of its cellular element.——The mode of NUTRITION OF THE FŒTUS IN UTERO has been discussed by A. Gusserow, in *Archiv f. Gynäkologie*, III., Heft 2, 1872, and experiments are recorded from which the author concludes that materials pass out of the mother into the fœtus, but that the process is very slow indeed in its nature.——Alphonse Milne Edwards communicates (*Ann. des Sc. Nat.* xv., 1871) important observations on the PLACENTA AND MEMBRANES OF THE LEMURS, with especial reference to the zoological affinities of these animals. He shows that essential differences exist between the placentation of these animals and the apes. In *Propithecus* almost the whole of the surface of the ovum adheres to the inner face of the uterus, and the chorion is almost entirely covered with thick, compact villosities, constituting a sort of vascular cushion, and resulting from the confluence of a multitude of irregular cotyledons. The placenta presents the appearance of a large sac, which almost completely encloses, as in a hood, the amnion, and which Edwards denominates a bell-like placenta (*placenta en cloche*), for the villi are the most numerous at the upper and middle parts of the chorion, but disappear almost entirely at the cephalic pole. A caducous layer is developed on the uterine mucous surface in the region corresponding to the villosities of the chorion. The allantois is enormously developed, and, in this particular, *propithecus* is distinguished from the apes, bats, insectivora, rodents, and even the carnivora. Hence in the lemurs the membranes are arranged in a manner peculiar to that group, one which is much more removed from that of man, apes, rodents and insectivora, than it is even from the carnivora. Taking into consideration the placentation, the brain, cranium, teeth and hands, Edwards considers that a fundamental difference exists between the apes and lemurs, and that the latter should be regarded as forming a distinct order of mammalia.—— Winogradow (*Virchow's Archiv*, LIV. 78) relates some observations on the STRUCTURE of the HUMAN AMNION. The epithelium on its inner surface is a stunted cylindrical epithelium. Between these cells are found at intervals clear vesicles with well-defined boundaries, containing each a nucleus. These vesicles occur more frequently on the placental part of the amnion. He has studied the connective tissue of the amnion to ascertain if the lymph-vessels which Köster found in the umbilical cord also occur in it, and has found delicate canals, with thin walls, forming a close network, and here and there displaying dilatations in which round or oval nuclei are seen. These canals are in the form of branching cells, and he believes them to be the rootlets of the lymph-vessels. They are in connection with similar canals in the chorion.——In a contribution to (*Schultze's Archiv*, VII. 192) our knowledge of the AMNION, S. L. Schenk concludes from his observations that the amnion arises as a protrusion from the primordial vertebræ, and consists in part of the offspring of cells which are formed by the process of subdivision, and in part of metamorphosed elements which proceed out of the blood-channels. Changes take place in these elements which lead to the conversion of the same into the tissues of the fully-developed amnion.

MUSCULAR SYSTEM.—J. B. Perrin records (*Med. Times and Gaz.* May 27, 1871) a specimen of left *M. supra-costalis* which arose from the second costal cartilage, passed obliquely upwards and outwards, perforated the upper sternal fibres of the greater pectoral, passed behind the portio attollens to be inserted into the costo-coracoid membrane, close to the clavicle.—— Wenzel Gruber (*Virchow's Archiv*, LIV. 184) relates a case in which the *left deltoid* was deficient in its middle portion, and on p. 186 a case where the left pronator quadratus was defective, but a special *m. tensor capsulæ radio-cubitalis inferioris* was developed. Gruber also in *Bull. de l'Acad. imp. de St Pétersb.*, Dec. 1870, relates a case in which in the left lower limb a *m. tensor fasciæ suralis* arose from the tendon of the long head of the biceps and was inserted into the fascia of the calf of the leg, and in both lower limbs a *m. tensor capsulæ genualis posterior. superior.* arose from the linea aspera to end in the upper part of the posterior ligament of the knee-joint; in the same *Bulletin*, April 1871, he describes a *m. cubito-carpeus* and a *m. radio-cubito-carpeus biceps.*——W. Turner records here a specimen of *m. tensor fasciæ suralis* which he met with in the right lower limb of a subject dissected in the winter session of 1866—67. This muscle differed from the one observed by Gruber, for it arose at the upper part of the back of the thigh, as a distinct offshoot of the muscular part of the semi-tendinosus; it terminated in a very thin rounded tendon, which, after course of 2½ in., joined a fusiform muscle nearly 3 in. long, which lay in the fat superficial to the internal popliteal nerve, and which ended in a thin expanded tendon that joined the fascia of the calf of the leg opposite the inferior angle of the popliteal space. W. Turner also saw, in Jan. 1869, a *m. tensor fasciæ poplitealis* of the right limb, which arose by two heads; one, a broad, thin band of muscle arose from the linea aspera, between the origins of the short head of the biceps and the vastus externus, and the fibres of which passed directly backwards; the other arose from the long tendon of the biceps, 4 in. below the ischial tuber, and passed down the back of the thigh to join the other head, and to be inserted along with it into the deep surface of the fascia at the upper angle of the popliteal space.——J. H. L. Flögel describes (*Schultze's Archiv*, VIII. 69) the STRUCTURE OF THE STRIPED MUSCULAR FIBRE in *Trombidium* and *Cyclops:* W. Dönitz contributes to the same subject by recording (*Reichert u. Du Bois Reymond's Archiv*, Feb. 1872) his observations on the striped fibre of the *Siphonophora.*——Fr. Merkel in *Schultze's Archiv*, Jan. 1872, investigates the striped fibre in the *Arthropoda;* this paper has already had an abstract made of it in *Quart. Journ. Mic. Sc.*, April, 1872.

CONNECTIVE TISSUE AND SEROUS MEMBRANES. — An elaborate critical memoir, with a number of new observations, on the STRUCTURE AND DEVELOPMENT OF CONNECTIVE TISSUE, by Franz Boll, is in *Schultze's Archiv* for 1871. The structure of tendons, of fibrillated connective tissue, of the connective tissue of the arachnoid, and of the subcutaneous tissue, is carefully investigated. Boll describes the cell-elements of young tendons as consisting of granular masses of nucleated protoplasm, arranged in the form of plates, which lie around the bundles of fibrillæ. As his views have, however, been concisely stated and criticized by Mitchell Bruce in *Quart. Journ. Mic. Sc.*, April, 1872, reference may be made to that *Journal* for further information, to which *Journal* also E. Klein and Burdon Sanderson have communicated a preliminary notice of researches on the ANATOMY OF SEROUS MEMBRANES.

TEETH.—In *Brit. Med. Journ.*, Feb. 28, 1871, and several subsequent numbers, W. H. Flower publishes an Abstract of his Course of Hunterian Lectures on the *Teeth and Allied Organs in the Mammalia;* and in *Trans. Odontological Soc.*, May 1, 1871, he records some notes on the *Milk Dentition of the Mammalia*, in which he has endeavoured to fix the period of retention of the milk-teeth as related to the general development of the body, especially with reference to the condition of the various epiphyses of the skeleton at the time that the last milk molar is replaced by its permanent successor. ——G. Rolleston makes observations (*Quart. Mic. Journ.* April, 1872) on the *Development of the Enamel in the Teeth of Mammals*, as illustrated by the 4th molar of a young elephant and the incisors of a fœtal calf.——Santi Sirena relates his observations (*Centralblatt*, 1870, No. 48) on the *Development of the Teeth in some Reptiles and Amphibia.*

ORGANS OF SENSE.—Reichert in his and *Du Bois Reymond's Archiv*, 1871, describes the MINUTE ANATOMY OF THE COCHLEA in man and in animals; the same subject is also considered in *Schultze's Archiv*, Jan. 1872, by J. Gottstein and by Nuel, and in the same *Archiv* for 1871, H. Leydig investigates the ORGAN OF HEARING OF THE GASTEROPODA, and Jos. Schöbl points out in the OUTER EAR OF THE MOUSE structural arrangements which convert the pinna into an organ of touch. That the SNOUT OF THE MOLE is an important instrument of touch, is shown by Th. Eimer in *Schultze's Archiv* for 1871, and in the same *Archiv* for 1872, p. 274, L. Stieda, whilst confirming the observations of Schöbl as to the great abundance of nerve-fibres in the mouse's ear and bat's wing, yet considers that the peculiar bodies described by Schöbl are not terminal nerve-organs, but collections of cells belonging to the hair roots and concerned in the reproduction of the hairs.

The STRUCTURE OF THE RETINA is further illustrated by Max. Schultze in his *Archiv*, May, 1871, and by Dobrowolsky in *Reichert u. du Bois Reymond's Archiv* for August 1871, whilst F. Morano describes in *Schultze's Archiv*, Nov. 1871, the pigment layer of the retina, and Robinski in *Reichert's Archiv*, Feb. 1872, criticizes the methods employed in the investigation of the crystalline lens.

MALFORMATIONS.—Wenzel Gruber communicates (*Bull. de l'Acad. imp. de St Pétersb.*, April, May, October, 1871) additional cases of POLYDACTYLISM (Report, v. 382). In one case the right hand possessed six metacarpals and six digits, the left hand six metacarpals and seven digits (five fingers and two thumbs); each foot also had six metatarsals and six toes. In another case he dissected a right arm with a supernumerary thumb, and in another a left arm with duplicity of the thumb. Küttner describes (*Virchow's Archiv*, LIV. 34) a case of CONGENITAL ATRESIA OF THE SMALL INTESTINE, in which the jejunum terminated and the ileum commenced each in a *cul-de-sac*, the intermediate part of the gut and the corresponding portion of the mesentery being wanting. He discusses how the atresia has been occasioned, and concludes that it was not due to fœtal peritonitis, to constriction from processes of the amnion or to embolism of the superior mesenteric artery, but to twisting of the fœtal intestine on its axis.

MISCELLANEOUS.—Daniel Wilson gives, in *Canadian Journ.*, 1871, an account of the HURON RACE and its HEAD FORMS; the study of a large number of skulls has led him to the conclusion that considerable variation occurs in their form, even in the same tribe, but that the dolicocephalic character is fully borne out. The doctrine of a homogeneous cranial type for the American aborigines, laid down by Samuel Morton, has everywhere failed to be substantiated, when subjected to the test of detailed observation.—D. Wilson discusses RIGHTHANDEDNESS in the *Canadian Journal*, Feb. 1872, and comes to the conclusion, that with a certain number of persons the preferential use of the right hand is instinctive and natural, with a smaller number an equally strong impulse is felt to use the left hand, but that with the great majority righthandedness is mainly, if not solely, the result of education.—Burt G. Wilder publishes a popular lecture on HUMAN LOCOMOTION, or 'how we stand, walk and run.'—Ludwig Meyer (*Virchow's Archiv*, LIII.) records several cases of POINTED EARS occurring in man, to which attention was directed by C. Darwin last year in his work on the Descent of Man.

COMPARATIVE ANATOMY.

VERTEBRATA.—SIMIÆ.—Researches on the *Myology of Mycetes Fuscus*, by Santi Sirena (*Gazzetta delle Cliniche di Torino*, 1871) contain a description of a muscle of the neck, which he calls *m. transversus maxillæ inferioris*, extending from the inner surface of the horizontal ramus of one side of the lower jaw to a corresponding spot on the other; also a *m. costo-thyroideus* from the superior border of the thyroid cartilage to the first rib, on the same plane as the sterno-thyroid, and like the muscle described by Sandifort in *mycetes*. He has carefully examined the muscles of the hand and fingers, the muscles of the haunch, the muscles of the leg and foot.

LEMURS.—Paul Gervais publishes (*Journal de Zoologie*, 1872) a memoir on the *Form of the Encephalon in this Order of Mammals*. Whilst the lemurs in certain particulars, as in the disposition of some convolutions in a double arc around the Sylvian fissure, approach the carnivora, they on the other hand have certain analogies with the apes, and at the same time approximate to the proper insectivora through their smallest species. With reference to their affinities to the carnivora, the lemurs have never more than two convolutions around the Sylvian fissure, and in certain cases these are wanting, whilst in the carnivora at least three are always present.——Alphonse M. Edwards's memoir on the *placentation of the lemurs* has already been referred to in the section on the uterus.

CETACEA.—Several memoirs on the Anatomy of Whales have appeared since our last Report. Jas. Murie has communicated to *Journ. Linn. Soc.* xi. notes on LAGENORHYNCHUS ALBIROSTRIS. He describes the dentition, the mouth, pharynx, larynx, articulation of lower jaw, blowhole and diverticular chambers, kidneys, penis, and pelvo-caudal parts. He also describes some of the muscles, and figures those connected with the blowholes.——J. W. Clark describes (*Proc. Zool. Soc.*, Jan. 17, 1871) a skull of MONODON MONOCEROS in the Cambridge Museum, which possesses two fully-developed tusks. He remarks that in the normal dentition the left tusk only is developed in the male narwhal, whilst in the female both tusks remain abortive. From the examination of several narwhal crania he concludes that the alveolus of the tooth is hollowed out in the maxillary alone, and in no other bone whatever. He states that eleven bidental skulls now exist in different European museums.——J. B. Perrin notes (*Proc. Zool. Soc.*, Dec. 6, 1870) some points in the anatomy of a BALÆNOPTERA ROSTRATA, 13ft. 8½in. long. The cranio-mandibular and scapulo-humeral articulations, together with the muscular arrangements of the flipper, are more particularly described. Observations are also made on the pelvic bones which were still cartilaginous, and it is stated that at the summit of the outer convexity was "a small rough fibrous mass, about the size of a pea, in which were imbedded a number of very small cartilaginous plates. This is evidently the rudimentary representative of the femur."——P. J. van Beneden records (*Mêm. de l'Acad. Roy. de Belgique*, 1871) various points in the anatomy of a specimen of BALÆNOPTERA MUSCULUS captured in the Scheldt. The skeleton is particularly described, and it is pointed out that the fist rib both on the right and left sides is bifid at its vertebral end.——Reference may also be made to the communication by Wm. Turner in this *Journal*, May 1871, on the so-called TWO-HEADED RIBS IN WHALES, AND IN MAN, and to the memoir by John Struthers on BALÆNOPTERA MUSCULUS in this *Journal*, Nov., 1871, in which the pelvic bones, the ribs, sternum and muscles of the flipper are described.——A. W. Malm contributes an important memoir (*Kongl. svensk. vetenskaps Akad. Handl.* ix. 1870) on the various CETACEAN SKELETONS in the different museums in Sweden, which is illustrated with six quarto plates. The composition of the carpus is more especially enquired into.——J. E. Gray notes the characters (*Annals Nat. Hist.*, Aug. 1871) of the Berardius of New Zealand; and W. H. Flower (*Nature*, Dec. 7th, 1871) gives a short summary of the known zoological facts relating to the different animals of which each group of ZIPHOID WHALES is composed. He distinguishes four genera, HYPEROODON, ZIPHIUS, MESOPLODON and BERARDIUS.——M. P. Fischer quotes from a series of interesting documents (*Ann. des Sc., Nat.* xv. 1) relative to the BALÆNA BISCAYENSIS. He considers that two species of true Balaenae exist in the temperate regions of the Atlantic, both of which differ from the B. MYSTICETUS.——W. Turner records (*Proc. Roy. Soc. Ed.*, Jan., 1872) additional notes on the occurrence of the SPERM WHALE IN THE SCOTTISH SEAS.——An abstract of a memoir by H. Burmeister on four species of DELPHINIDÆ frequenting the coasts of the Argentine Republic, is in Gervais's *Journal de Zoologie*, I. 1872.

SIRENIA.—Alex. Brandt gives an account (*Mém. de l'Acad. des Sc. de St Pétersb.*, 1871) of the structure of the skin of RHYTINA BOREALIS, and of a species of CYAMUS parasitic on it, which he calls C. RHYTINÆ, a form closely allied to C. OVALIS. An abstract of this paper, with a critical commentary thereon, by Jas. Murie, is in *Ann. Nat. Hist.*, April, 1872. The latter author agrees with Brandt in regarding the skin as essentially corresponding in minute structure to that of the Manatee and the Cetacea, but he dissents from his conclusion that its surface was smooth, for he believes it to have been rough and corrugated, as in the Manatee itself.

SEALS.—James Hector notes the characters of some NEW ZEALAND EARED SEALS (*Ann. Nat. Hist.*, July, 1871); and in the December number of the same *Annals* he gives the measurements of the skull of a full-grown animal, which he names ARCTOCEPHALUS FORSTERI. ——A translation of H. Burmeister's notes on ARCTOCEPHALUS HOOKERI appears also in the same *Annals*, Jan. 1872.——The *Trans. Zool. Soc.*, VII., contain two elaborate contributions by Jas. Murie to the ANATOMY OF THE PINNIPEDIA. The first, on the Walrus, describes the external characters, the dentition, and the cavity of the mouth, the viscera and generative organs, the vascular and respiratory systems, and the myology. Five beautifully-executed plates illustrate this memoir. The second treats of the external characters, the attitudes, muscular and ligamentous systems of the sea-lion, OTARIA JUBATA, and is illustrated by seven large lithographic plates.—— W. H. Flower describes the characters (*Proc. Zool. Soc.*, June 6, 1871) of a seal's skull in the Norwich Museum, obtained from a specimen caught on the coast of Norfolk, which he refers to PHOCA HISPIDA.——P. J. van Beneden (*Bull. de l'Acad. Roy. de Belgique*, July, 1871) records the remains of the fossil seals, *de la mer Scaldisienne*, which he refers to the following species: PHOCA VITULINOIDES, PALÆOPHOCA NYSTII, TRICHECODON KONINCKII and ALACHTERIUM CRETSII.

CARNIVORA.—In *Proc. Zool. Soc.*, Nov. 15, 1870, W. H. Flower contributes to the anatomy of ÆLURUS FULGENS. He describes the brain, mouth, tongue, larynx, thoracic abdominal and pelvic viscera. ——In *Trans. Zool. Soc.*, VII., Jas. Murie describes the female organs of generation, the viscera and fleshy parts of HYÆNA BRUNNEA.

RUMINANTIA.——Jas. Murie communicates some observations (*Ann. Nat. Hist.*, March, 1872) on the horns, viscera, and muscles of CAMELOPARDALIS; and in the *Geological Mag.*, Oct., 1871, he discusses the systematic position of the SIVATHERIUM GIGANTEUM.

BIRDS.—J. Reinhardt in *Vidensk Meddel. fra den naturhist. Foren. i. Kjöbenhavn*, 1871, describes a hitherto unrecognised bone in the *cranium of the Musophagidæ.* He has found it in all the genera, though its form varies somewhat. It articulates by its upper truncated border with the outer part of the lower border of the lamina papyracea, whilst externally it is in contact with the inferior part of the lachrymal. A little lower down it is attached by connective tissue to the lower border of the zygomatic arch, and it terminates on the level of the palate, with the outer border of which it is connected by a short ligament. He names it *os crochu* (*os uncinatum*), and it is identical with the bone of the same name described by Magnus in *Phœnicophæus viridis* and with the bone in the frigates and petrels which Brandt has called *ossiculum lacrymo-palatinum.*——W. H. Flower records (*Proc. Zool. Soc.*, Jan. 3, 1871) some observations on the *skeleton of Casuarius australis*, which he compares with *C. galeatus.*——Some points in the *Osteology of Rhea americana* and *R. darwinii* are related (*Proc. Zool. Soc.*, Feb. 7, 1871) by R. O. Cunningham, and the same naturalist communicates to the *Trans.* of the same *Society*, VII., observations on the *anatomy* of the *steamer duck, Micropterus cinereus.* The memoir has five beautifully executed quarto plates, principally in illustration of the osteology of this bird.——John Young in this *Journal*, Nov. 1871, records some observations on the *shoulder of birds*, and in the same number Jas. Murie describes the sternum and viscera of Pell's owl (*Scotopelia peli*).——Jas. Murie also communicates to *Trans. Zool. Soc.*, VII. 465) a beautifully illustrated memoir on the *dermal and visceral structures of the Kagu, Sun-bittern and Boatbill.* The peculiarities of the plumage are described with great minuteness.——Robby Kossmann gives an account (*Siebold u. Kölliker's Zeitsch.*, 1871, 568) of the *caudal sebaceous glands of birds.*

REPTILIA.—Researches on the STRUCTURE of the OVA OF REPTILES are communicated by Th. Eimer to *Schultze's Archiv*, Jan. 1872.

BATRACHIA.—Henry Gervais, in *Journ. de Zoologie*, 1872, describes a peculiar *hydropic condition of an Axolotl.*

FISHES.—G. B. Ercolani communicates to the *Accad. delle Scienze di Bologna*, 28 Dec., 1871, a note on PERFECT HERMAPHRODITISM IN THE EEL. He has studied both the fresh- and salt-water specimens of this fish. He finds in the fresh-water specimens two organs which had previously escaped observation. The one was constantly placed on the right side between the ovary and the intestine, but was smaller than the ovary; the author judged it to be a third rudimentary plicated body (*corpo frangiato*). The other consisted of a large pyriform sac with thin parietes, rich in fat, but also possessing round or polygonal cells, and lay in close relation to the intestine. In the third plicated body no ova are found, but it is formed of a rich vascular reticulum which contains merely fat cells, larger in fresh-water than in salt-water eels in December. The pyriform sac in the salt-water eels contained on the parietes myriads of minute germinative corpuscles endowed with active movement and of a light orange colour. He considers these to be spermatozoa, and the sac therefore to be the testis. This sac only acquires its complete structure as a male genital gland in the eel after it has reached the salt water, and, as well developed ovaries also exist in the same fish, a perfect hermaphroditism is the result. He believes that both the ova and spermatozoa are discharged into the peritoneal cavity, so that the former are fertilized before emission from the body.——J. Canestrini (*Siebold u. Kölliker's Zeitsch.*, 1871, p. 538) describes the MALE OF COBITIS TÆNIA.——Albert Günther's description of CERATODUS, the new genus of Ganoids, has now appeared *in extenso* in *Trans. R. S. Lond.*, 1871. The various organic systems, excepting the nervous and circulatory, which will form the subjects of a separate memoir, have been treated of at considerable length, and the affinities of this fish, both to recent and fossil genera, have been discussed. The memoir is illustrated by thirteen elaborate plates.——C. Gegenbaur describes (*Jenaische Zeitsch.*, VI. 497) the CRANIAL NERVES OF HEXANTHUS with especial reference to the vertebral theory of the skull. He first describes these nerves in Hexanthus, then compares their modifications in nearly allied fishes, and considers their homologies with the cerebral nerves in the higher vertebrata. He decides the homology partly from the distribution of the nerves, but also from the relation which the different branches bear to the cranial walls, primordial or permanent. As the olfactory and optic nerves belong to regions of the cranium which have not been modified, it is needless, from the point of view of the vertebral theory of the skull, to expect an agreement between them and the spinal nerves in arrangement and distribution. The ophthalmic division of the 5th he considers to correspond with the dorsal branch of a spinal nerve, the 2nd and 3rd divisions with the ventral branch. The 3rd, 4th and 6th nerves belong to the trigeminal group. The facial and auditory represent a single spinal nerve, though whether the latter is an otherwise absent dorsal branch of the facial the author does not say. The vagus represents, not a single spinal nerve, but a number. The medulla oblongata is an antero-posteriorly shortened part of the spinal cord, so that the roots of the various spinal nerves represented by the vagus are brought close together. The skull may be divided into a vertebral or cerebral, and an evertebral or facial section; the latter is fitted for the reception of the sense organs, whilst the former accommodates only one sense organ—the ear.

INVERTEBRATA.—George Allman contributes (*Trans. R. S. Edinburgh*, 1871) a memoir on the HOMOLOGICAL RELATIONS OF THE CŒLENTERATA.——To *Mém. de l'Acad. des Sciences de St Pétersb.*, 1871, A. Kowallevski communicates a memoir on the EMBRYOLOGY OF VARIOUS VERMES and ARTHROPODA.——D. Robertson notes (*Quart. Journ. Mic. Sc.*, XI.) some points connected with the structure and habits of AMPHIDOTUS CORDATUS.——Albert Kölliker (*Verhand. phys. med. Ges. in Würzburg*, Feb. 4, 1871) gives an account of the STRUCTURE OF RENILLA.——E. van Beneden publishes (*Bull. de l'Acad. Roy. de Belgique*, XXXI., 1871) researches on the EVOLUTION OF THE GREGARINIDÆ. In the course of its development a Gregarina passes through the following phases: *monérienne, cytode générateur, pseudofilaire, protoplaste, grégarine enkystée, psorospermie.* The Gregarinidæ should be arranged along with the true Amœbæ to constitute the group of protoplasts. A translation of this paper has been given in *Quart. Journ. Mic. Sc.*, July, 1871; in which number also a paper, by A. S. Packard, on the EMBRYOLOGY OF LIMULUS POLYPHEMUS, and one by W. S. Kent on the larval form of an ACANTHO-CEPHALOID SCOLECID also appear.——In *Siebold u. Kölliker's Zeits.*, 1871, R. v. Willemoes-Suhm records observations on some *Trematodes* and *Nemathelmintha;* on the development of a *Peridinium;* on *Balanoglossus Kupfferi;* on *Halicryptus spinulosus;* on *Priapulus caudatus;* on *Eteone pusilla, Terebella zostirecola, Terebillides stroemii,* and *Spirorbis nautiloides.* O. Bütschli relates his researches on the nematodes of *Periplaneta* (*Blatta*) *orientalis;* on the STRUCTURE AND DEVELOPMENT OF THE SPERMATOZOA IN INSECTS AND CRUSTACEA. H. Nitsche contributes to our knowledge of the *Bryozoa* and A. Schneider to that of the *Radiolaria.* Ehlers also gives an account of a new sponge, *Aulorhipis elegans.* Elias Metschnikoff contributes to our knowledge of the embryology of the Scorpions; of the metamorphosis of *Mitraria* and *Actinotrocha;* of the Nauplius condition of *Euphausia,* and to the history of the development of *Chelifex.* In a second memoir on the structure and development of the Arthropoda, Anton Dohrn adds to our knowledge of the *Malacostraca* and their larval forms; A. Stuart describes the nervous system of *Creceis acicula.*

REPORT ON THE PROGRESS OF PHYSIOLOGY. By W. RUTHERFORD, M.D., F.R.S.E. *Professor of Physiology in King's College, London;* THOMAS FRASER, M.D., F.R.S.E., F.R.C.P.E., *Assistant Physician to the Royal Infirmary, Edinburgh;* T. LAUDER BRUNTON, M.D., D. Sc., *Joint-Lecturer on Materia Medica and Therapeutics, St Bartholomew's Hospital, and* DAVID FERRIER, M.A., M.D., *Professor of Forensic Medicine, King's College, London.*

DR RUTHERFORD'S REPORT.

Physiological Chemistry.

Blood.

BLOOD-PIGMENT.—W. Preyer has published an important Memoir entitled *Die Blutkrystalle* (8vo. pp. 263, Jena, 1871), in which he recounts what is already known regarding the blood-pigment, together with very many original observations thereon.

No one is better qualified than Preyer to write on such a subject. He has been doing good work upon it for several years. The book is a pleasant one to read, not only because of the deeply interesting nature of its theme, but also because Preyer, unlike many Germans, is able to write good German. Of course a language, where the cart is generally put before the horse, is anything but well adapted for serving as the vehicle of Physical Science—where the horse invariably goes before the cart. Nevertheless, Preyer reminds us that there are some of our learned cousins who successfully struggle against the tendency to involved expression which seems to overcome so many of them.

Preyer states that Hæmoglobin (for the sake of brevity we will express this by its symbol Hb) occurs in the blood of all vertebrates, Amphioxus included (W. Müller), in one mollusc, Planorbis (Lankester), two Arthropods, Cheironomus and Cheirocephalus, and in two worms, Nephelis and Lumbricus. It has not been found in Echinoderms, Cœlenterates, Protozoa, or in plants. In vertebrates it exists in the blood-corpuscles, and there is no conclusive evidence that it is found in the serum. In some invertebrates it exists entirely in the serum. Regarding its occurrence in muscular tissue he quotes Ray Lankester's discovery (p. 261), that it is found in the pharyngeal muscles of gasteropods, although it does not exist in the blood (see *Journ. of Anat. and Phys.* No. IX. p. 241). This valuable fact has upset Brozeit's opinion that the Hb of muscle is merely derived from the blood, and not—as Kühne supposed—inherent in the muscle itself.

Regarding the preparation of blood-crystals, Preyer finds that the presence of light—so much insisted upon by some observers—is unimportant. He has obtained crystals as readily in the dark as in sunshine. Hb crystallizes most readily from a concentrated solution, saturated with oxygen, kept cool and at rest. He describes the methods previously given for obtaining crystallized Hb in large quantities. The following method is the one which he prefers for obtaining from any kind of blood large Hb crystals in a pure state. (1) Collect blood in a basin, let it coagulate and allow it to stand for a day in a cool place. (2) Pour off serum, slightly wash the clot with a stream of cold distilled water. (3) Cut it into small pieces, and again wash with cold distilled water. (4) Reduce the clot to a state of very fine division. This is best done by freezing and then pulverising the frozen clot in a mortar. (5) Place the powdered clot on a filter and wash it with cold distilled water until the filtrate ceases to give a dense pp. with Corrosive Sublimate. (6) Wash the clot with water heated to 30°—40° (cent.), and let the filtrate drop into a large cylinder standing in ice. (7) Take a small (measured) portion of the filtrate, and, while constantly shaking it, add small quantities of alcohol until a precipitate appear. (8) Observe how much alcohol was necessary to cause precipitation, and then add to the remainder of the filtrate a quantity of alcohol just *short of that* necessary to cause precipitation. (9) Let the mixture rest. Crystals form in a few hours. (10) Filter and wash the crystals with ice-cold water containing at first a little alcohol. If great purity be desired, the crystals must be washed until the filtrate does not become cloudy on the addition of Corrosive Sublimate, Acetate of Lead, and Nitrate of Silver. [A method so tedious and expensive is not likely to be much used for *ordinary* purposes, seeing that the following simple method answers remarkably well. Add to fresh defibrinated dog's blood 1¼ times its volume of cold water. Let stand for three hours, and then add ¼ of its volume of rectified spirit. Place in a beaker and leave this over-night in a basket of sawdust containing a mixture of ice and salt. In the morning the fluid will be found to contain crystals. These may be washed by throwing them on a filter and washing them with extremely small quantities of distilled water. This method is a modification of Hoppe-Seyler's.] Preyer also gives the various methods for obtaining a small quantity of Hb crystals. He prefers the following (p. 25), which may be used with *any kind* of blood. Take a few cubic centimetres of defibrinated blood, add water until it become transparent. Place a drop of this upon a slide, cover with a thin glass, and allow to evaporate slowly in a cool place. If it do not crystallize, add to the diluted blood ¼ of its volume of alcohol, put it in a platinum or silver cup, and place this in a cooling mixture. This will always produce crystallization. This method evidently requires a good deal of time. For ordinary purposes one can readily obtain crystals by driving air containing a little chloroform vapour through defibrinated guinea-pig's blood for a short time, and then slowly evaporating a drop on a slide (J. Bernstein). Schultze's method is also excellent. Heat defibrinated blood of horse or guinea-pig in a water-bath, or on a slide under a cover glass—to at least 60°, but not over 64° cent. Allow this to cool and evaporate. Bojanowski's method is also convenient. (See Huxley's *Physiology*, 3rd ed. p. 72.) In order to get the Hb to crystallize it is necessary to get it partially or completely out of the corpuscles. This may be effected by freezing and afterwards thawing blood (*most* bloods crystallize after they have been frozen), by adding to the blood water—especially water heated to 30°—40° cent., by adding small quantities of Chloroform or Ether, by transmitting through it induced electrical shocks—or by rupturing the corpuscles by shaking blood with iron filings, &c. It is a remarkable fact that Hb, a crystalline substance, remains within the stroma of the corpuscles, and does not diffuse into the surrounding blood-serum. It is commonly said to be "fixed" by the stroma—the nature of this "fixation" is not known. It appears quite certain, however, that the two do not cling very closely to one another: for electrical shocks, or the mere addition of water, can, without destroying the corpuscles, permit the Hb to escape. It has been suggested that the corpuscles are enclosed in a membrane whose pores are not large enough to permit of the molecules (*Chemical* molecules) of Hb to escape. This membrane has never been shown to exist in the Mammalian corpuscle at any rate (Preyer). [Nevertheless the outer part of the corpuscle may be denser than the interior, and the diffusion of the Hb which follows the addition of water and chloroform, &c. may be owing to a softening (diminution in density) of the stroma of the corpuscle. That such is the case appears probable from the fact that water causes the corpuscles to lose elasticity, to swell up, and become globular. The Hb is probably merely diffused throughout the stroma although incarcerated by it.] What is the chemical nature of the Hb inside the corpuscles? Towards Oxygen, Carbonic Oxide, etc., the Hb in the corpuscles behaves just as it does when liberated from them. In chemical composition the Hb seems to undergo no change when it leaves the stroma, but nevertheless Preyer maintains that the Hb inside the corpuscle is probably not isolated but in a state of combination with an alkali, to wit, Potash. Pure Hb is very insoluble, 1 grm. of guinea-pig's Hb requiring 600 grms. of water for its solution. The blood-corpuscles contain very little water, not enough, in Preyer's opinion, to dissolve the Hb if it exist in the free state, but sufficient if it be combined with an alkali. Preyer's defence of this opinion must be perused in the original (p. 28). To us it does not appear quite convincing.

The animals from which Hb has already been obtained in a crystalline state are enumerated by Preyer (p. 36). The chief are man, hedgehog, cat, dog, guinea-pig, squirrel, mouse, rabbit, ox, sheep, horse, pigeon, goose, frog, lizard, tortoise, perch, pike, herring, earthworm. The forms of the crystals vary. All, however, belong either to the rhombic or to the hexagonal systems. It is commonly stated that in the guinea-pig the crystals are tetragonal, but Von Lang's exact investigations shew that they belong to the rhombic system. In most animals the crystals are rhombic prisms more or less closely resembling those of man. In the squirrel and some rodents they are hexagonal. All Hb crystals doubly refract light. Crystals in which the Hb is oxidised are monochroitic. Those in which the Hb is reduced are pleochromatic. The pleochromatism differs according to the "system;" those belonging to the rhombic system (e.g. man) being dichroitic, and those of the hexagonal system being trichroitic.

The two absorption bands which characterise the spectrum of Hb when combined with oxygen were discovered by Hoppe-Seyler in 1862. Stokes in 1864 announced the discovery that only oxyhæmoglobin gives two absorption bands: if the hæmoglobin be deprived of its oxygen, the spectrum shows only one band. These important revelations have led to very numerous researches on the spectra produced by altering the chemical relations of Hb in various ways. Two valuable chromolithographs are given by Preyer showing thirty spectra of Hb and its derivatives, chlorophyll, &c. The specific gravity of dry Hb probably lies between 1·3 and 1·4. Hb is soluble in water, but in degree of solubility it varies much in different animals. That of the guinea-pig and squirrel is the least soluble. Hb is insoluble in strong alcohol, ether, etherial and fatty oils. Pure Hb crystals—in the case of the dog at any rate—are also insoluble in benzole, turpentine, chloroform, amylic alcohol. Hb, as Kühne pointed out, is not in the least degree fibrino-plastic; that is, it cannot with fibrinogen produce fibrin. A. Schmidt said that it could, but he has recently retracted his error (*Centralblatt*, 1871, No. 48). Preyer shows that if the Hb be not thoroughly purified it produces a coagulum in a fibrinogenous fluid, such as Hydrocele Serum. Schmidt also stated that Hb could diffuse through parchment. This statement can only be explained by supposing that he used very bad parchment. It is quite certain that it does not diffuse through good parchment. This non-diffusibility is very remarkable, for it is a "crystalloid." Preyer avails himself of the non-diffusibility of Hb to test vegetable parchment. The parchment is suitable for dialysis if Hb do not diffuse through it. The pigment of diabetic urine and of a solution of curare also serve as tests. If blood-crystals be dried at a temperature below 0° cent. they preserve their bright red colour, and do not undergo decomposition. Hb dried in this way can be exposed for hours to a temperature of 100° cent. without decomposing. If undried crystals be heated in this way, or even if they be exposed to the air for a time at a temperature above 0° cent., they decompose. A brownish red substance, Methhæmoglobin, is produced, and also a colourless albuminous matter insoluble in water, which Preyer designates Globin. The composition of the latter he has not yet closely investigated, but it burns on platinum foil without leaving the slightest trace of ash, and seems to be a pure albumen. A watery solution of Hb coagulates when heated. It is not, however, the Hb which coagulates in this case, but albuminous matters resulting from the decomposition of the Hb. There seems to be a number of these coagulating temperatures which lie between 64° and 68·5° cent. The analyses of Hb performed by Hoppe-Seyler and C. Schmidt agree in a remarkable manner. The mean result of the analyses of dry hæmoglobin is C 54, H 7·25, N 16·25, Fe 0·42, S 0·63, O 21·45. From this Preyer calculates the following startling formula C_{600}, H_{960}, N_{154}, Fe_{1}, S_{3}, O_{179}. The molecular weight he estimates at 13332, and the equivalent weight at 4444·4—exactly one-third of the molecular weight. In composition the Hb of Man, Dog, Ox, Goose, Guinea-pig and Squirrel seem to be nearly if not indeed quite identical. [How remarkable that the solubility and crystalline forms should vary, while the chemical relations appear to be the same in all.] Oxidised Hb is a feeble acid. It bleaches very sensitive cyanin paper, and it renders very sensitive litmus paper violet. It decomposes Sodium Carbonate even at 0° cent., and, as shown by A. Schmidt, it crystallises undecomposed at the + pole of a galvanic current. Preyer describes at great length the action of numerous acids and alkaline substances upon Hb. The acids decompose a watery solution of Hb. The nature of the decomposition varies much. In dilute alkaline solutions Hb dissolves readily, possibly owing to the formation of an alkaline compound with the Hb. Decomposition of the Hb does not result unless the solution of the alkali be concentrated, or unless the dilute solution be heated. The account of the actions of acids, alkalies, and various salts, such as cupric sulphate, mercuric chloride, &c., must however be perused in the original. With regard to the action of urine on Hb, Preyer gives some interesting facts (p. 92). If *pure* Hb be dissolved in urine, the characteristic spectrum is given by the solution for a long time. If *blood* be mixed with urine, the spectroscopic characters soon disappear. At first there are the two bands of oxidised Hb. Soon a third band, that of Methæmoglobin, appears. In twenty-four hours or so the spectral characters disappear.

For the rapid reduction of oxy-hæmoglobin Preyer recommends sodium sulphide instead of ammonium sulphide. As is well known, if blood be allowed to stand for some time its colour becomes purple. This is owing to reduction of Hb. This reduction takes place before any putrefaction of the blood sets in, and the explanation which has been offered of the fact is that the blood contains substances which reduce the Hb. Without denying this, Preyer found that a solution of absolutely pure oxidized Hb in distilled water kept in an air-tight vessel at a temperature a little over 0° cent., became of a darker colour on the third day, and on the tenth day the colour was purple, the two bands of oxy-hæmoglobine had disappeared, and the single band of reduced Hb alone remained. On opening the bottle and exposing the fluid to air oxy-hæmoglobin was again produced. Decomposition of a part of the Hb had taken place, for the fluid contained globin. So when Hb decomposes it uses up its own loosely combined oxygen. In the spectroscopic examination of Hb it is important to remember that the degree of concentration of its solution greatly influences the spectral characters, e. g. if the solution contain less than 0·01 per cent. of the oxidised Hb it gives only one absorption band (the one near the line *D*), while if it contain more than 0·01 per cent. and less than 0·8 per cent. it gives two bands; but if the quantity be greater there is only one broad band, the space between the characteristic pair being completely darkened. A smaller quantity of blood may be detected by the microspectroscope than by any chemical test for blood (p. 110). But if blood be mixed with excess of aniline the Hb spectrum can no longer be seen. So blood may be present and the spectroscope may fail to show it. He regards the production of hæmin crystals as a valuable and certain test for the presence of blood, but states also that a failure to obtain these crystals is not sufficient to prove the absence of blood. If the blood be contaminated with putrefying substances it may yield no hæmin crystals. He recommends the following method for testing a stain supposed to be blood. 1. Place the stained substance in $\frac{1}{2}$ per cent. NaCl solution in order to extract the blood from it. 2. Examine the fluid with the microscope. If coloured blood-corpuscles are found the question is decided, if not, 3. Examine the fluid with the microspectroscope. If the spectrum of oxidised or reduced Hb, or Hæmatoidin or Hæmatin be seen, blood is certainly present. 4. If such spectra be not seen, search for hæmin; evaporate the fluid to dryness in a watch-glass at a temperature not higher than 50° cent., then add a little "very concentrated acetic acid," boil carefully for a minute or two, and then evaporate to dryness on a water-bath. Moisten the residue with water and look for crystals. If the black or dark brown crystals of hæmin are seen, the stain was certainly due to blood. 5. If no crystals be found, burn the residue on platinum and test for iron. If no iron be found, it was not blood; if iron be found while hæmin could not be obtained, it *may* have been blood. Preyer recommends the estimation of Hb by means of the spectroscope as the most convenient method for ascertaining the amount of blood in an animal (see pp. 116—131). One molecule of Hb combines loosely with one molecule of O, hence $Hb\,O_2$ is the symbol for oxy-hæmoglobin. The CO compound with Hb is Hb CO. As is known, the CO in this case, though it merely replaces the O_2 clings to the Hb much more firmly than the latter. CO can thrust out oxygen, but oxygen can no longer thrust out CO. A person poisoned with CO dies from lack of O. What is to be done with a person so poisoned? Kühne very reasonably recommended transfusion of blood. Pokrowsky has obtained unexpected results from a vigorous maintenance of artificial respiration. All the Hb may not be in the state of Hb CO; and it would appear probable, from Pokrowsky's successful results, that the CO becomes further oxidized, and is so got rid of (p. 144). [See abstract in *Journ. of Chem. Soc.* 1871, p. 839, of a recent paper by Bernard on "Action of Carbonic Oxide on Blood Globules." He supposes that in case of recovery from CO poisoning the CO is excreted unchanged. He gives no evidence in support of this.] The formula for the compound of Hb with nitric oxide is Hb NO. Regarding nitrite hæmoglobin Preyer (p. 150) is of opinion that the whole matter requires renewed investigation. The compound of Hb with Cyanogen gives two absorption bands, which Preyer says are certainly not, as Ray Lankester avers, identical with those of Hb CO, but with those of $Hb\,O_2$. Hydrocyanic Acid probably forms a compound both with oxidized and with reduced Hb. At p. 163 there is a table of all the formulæ for the various compounds of Hb. The only compounds whose formulæ have been unquestionably ascertained are $Hb\,O_2$, Hb CO and Hb NO. Preyer puts a mark of interrogation after all the others. Hb may be decomposed into a great number of substances which Preyer divides into three groups. I. Albumens. II. Pigments. III. Acids. As already mentioned, he gives the name Globin to an Albumen which he has obtained from pure Hb. When a watery solution of Hb is exposed for a considerable time to the air, Hb splits up into Methæmoglobin and Globin. Globin is a colourless substance, and appears to be a perfectly pure form of albumen. It has no fibrino-plastic power. By the action of acetic acid Hb is decomposed, and various acid albumens are produced. In like manner alkalies decompose Hb and give rise to alkaline albuminates.

Syntonine is also got from Hb by exposing it to the action of Hce. Globulin is also said to be obtained from Hb, but what is meant by the term Globulin it would be difficult to say. See p. 168 for a valuable list of the things which go under this indefinite name, which ought to be dropped altogether. Eight definite pigments have already been derived from Hb: Hæmin, Hæmatoin, Hæmatoidin, Hæmatochlorin, and Hæmatolutein crystallize; Methæmoglobin, Hæmatin and Hæmathion are amorphous. Hæmin and Hæmatoidin are well known. Hæmatoidin has never been obtained from Hb by artificial means. It is not generally known that it was first discovered by Sir Everard Home in 1830. Not only is this substance a certain proof of blood decomposition, but it excites much interest because of its supposed identity with the chief bile-pigment, Bilirubin. This supposed identity has caused many to regard the bile-pigment as one of the products of the decomposition of Hb. Yet are they identical? The composition of hæmatoidin has not been precisely ascertained. No doubt both substances form crystals of the same shape and colour, although the hæmatoidin crystals are far deeper in colour than those of the bile-pigment, but then the spectrum of hæmatoidin shows two bands, that of bilirubin no bands at all. The crystals of hæmatoidin are soluble, those of bilirubin are insoluble in ether containing fat (fetthaltigen Æther). There do not appear to be therefore any sufficient grounds for supposing that these substances are identical. There is, however, nothing opposed to the idea that bile-pigment may be derived from that of the blood. Hæmatoin is a bright red pigment obtained by acting on blood by Sulphuric Acid. It contains no iron. Methæmoglobin has been found in the dried blood of wounds. It may be obtained from blood-crystals by allowing them to stand for some months over Sulphuric acid in a glass chamber at the ordinary temperature when Hb decomposes into Methæmoglobin and the albumen Globin. Hæmathion is a green pigment which is formed by the action of HS on HbO_2. On the decomposition of HbO_2 in watery solution between 0° and 50° cent. acids appear. Hoppe-Seyler found butyric and formic acids, together with another strong non-volatile acid. In his concluding chapter Preyer discusses the changes which Hb undergoes in respiration, and the causes of these. We wish he had discussed this at greater length.

These interesting researches show more forcibly than ever that this substance, Hæmoglobin, is likely to give us a great insight into animal chemistry. Happily the substance, although it be the most complicated substance known, can be obtained in the pure state, and many of the products of its decomposition are of a definite description. It can indeed be taken to pieces, as it were, in a manner much more methodical than that which has yet obtained regarding any other albumenoid. We anticipate very much from a continuation of researches such as these.

CONTRIBUTIONS ON THE BLOOD OF MAN and MAMMALS.—On Hæmatin. Hoppe-Seyler (*Untersuch.* 1871, p. 523. See a long abstract by Dr Ferrier in *Chem. Soc. Journ.* 1871, p. 736.) Hæmatin does not simply result from the splitting up of Hæmoglobin, but results from decomposition accompanied by oxidation. If hæmoglobin in the absence of oxygen be reduced by hydrogen and decomposed by alcohol containing sulphuric acid or caustic potash, a pigment is produced which has a purple-red colour both in acid and alkaline solutions, and is characterised by definite absorption bands; he calls this Hæmochromogen. On being oxidised it forms Hæmatin. He has not succeeded in isolating this new pigment, nor has he been able to produce it by reducing Hæmatin. He regards Hæmoglobin as a compound of an albumenoid substance (Preyer's Globin) with a group of atoms constituting, when isolated, Hæmochromogen. The black pigment of the lungs and bronchial glands, and also the stellate pigment cells of *Amphibia*, seem to be a residue of Hæmatin, while urinary and bile-pigments appear to be products of Hæmochromogen. In atomic relations there is a very close affinity between Hæmochromogen and bilirubin. Numerous facts favour the idea that bilirubin is formed by the action of water and an acid on Hæmoglobin in the absence of oxygen.

Brondgeest (*Centralblatt*, 1871, No. 9) has obtained colourless crystals from frog's blood by freezing it previous to its coagulation. These crystals, he thinks, consist of Albumen derived from the blood-plasma.

INFLUENCE OF ACIDS ON THE OXYGEN OF HÆMOGLOBIN, Strassburg. (*Pflüger's Archiv*, IV. 454, abstract in *Centralblatt*, 1872, No. 2.)

FLUORESCING PRODUCT OF THE REDUCTION OF HÆMOGLOBIN, Stockvis. (See *Journ. of Anat. and Phys.* No. IX. p. 248.)

INFLUENCE OF NUTRITION ON THE AMOUNT OF HÆMOGLOBIN. Subbotin (*Zeitsch. für Biologie*, VII. 185).

INFLUENCE OF BILE AND BILE-ACIDS ON BLOOD-CORPUSCLES.—Jurasz. (Inaug Diss. Greifswald, 1871. Abstract in *Centralblatt*, 1872, No. 3.)

COAGULATION OF BLOOD.—A. Schmidt (*Centralblatt*, 1871, No. 48). Hæmoglobin, though it accelerates the coagulation of fluids which contain fibrinogen and fibrino-plastic matter, is not in itself fibrino-plastic. (See abstract of Preyer's memoir, supra.)

Nauyn (*Reichert's Archives*, 1866) has stated that if blood whose corpuscles have been disintegrated by freezing be injected into the jugular vein of a living animal, coagulation of the blood and death of the animal rapidly ensue; this he ascribed to the abundance of free fibrino-plastic substance introduced into the circulation. This view has received support from J. Ranke's experiments. (*Die Blutvertheilung und der Thätigkeitswechsel der Organe*, 8vo. pp. 191, Leipsic, 1871; abstract in *Centralblatt*, 1872, No. 6.) This observer found that when he injected pure solution of bile, or of the salts of the bile-acids, into the jugular vein, asphyxia and death rapidly supervened. The right heart and pulmonary artery contained coagula; the blood in the left heart was found to be fluid at death. Injection of a solution of bile-ash produced no disturbance. He ascribed the coagulation to the liberation of fibrino-plastic substance from the blood-corpuscles dissolved (as they have long been known to be) by the salts of the bile-acids. Schiffer (*Centralblatt*, 1872, No. 10) says the case is not so simple as these researches make it appear. He injected into the jugular vein of rabbits blood which had been frozen, and, although some died rapidly, others seemed to suffer no inconvenience, even though four or five and even eight CC had been injected. In only one of those that died did he find a clot in the pulmonary artery—in the others the blood in the right heart was fluid. The cause of death seems to have been very obscure, for not only did death ensue during the injection, but the death resulted in most cases when the blood was injected into the *peripheric* as well as into the central portion of the jugular vein. [Possibly it found its way into the circulating current by some collateral path. It would have been well to have injected such a substance as Potassium Ferrocyanide into the upper end of the jugular, and then to have examined the blood in the general circulation to see whether or not it had found its way thither.] In dogs he repeatedly injected as much as 25 CC of frozen blood, and death did not result. [He leaves us to infer that no coagula formed anywhere.] He therefore concludes that free fibrino-plastic matter may be introduced into the circulating blood, even in large quantities, without giving rise to coagulation.

ORIGIN OF FIBRIN AND CAUSE OF COAGULATION OF BLOOD.—Béclard showed that the blood of the splenic vein is poorer in red corpuscles, and richer in fibrin, than the blood of the jugular vein or the splenic artery. Gray confirmed this, and suggested that in the spleen the red corpuscles are partially destroyed, and fibrin is produced from their disintegration. Funke has opposed both of these authorities in this matter. To settle the difference Mantegazza has performed some experiments. (*Centralblatt*, 1871, No. 45.) He examined the blood of the splenic and jugular veins in fifteen dogs. In the majority of instances the splenic vein yielded more fibrin and fewer red corpuscles than the jugular blood, but in some cases both bloods were apparently identical, and in others the proportion was reversed.

The extirpation of the spleen in three rabbits was followed by no remarkable change in the amount of fibrin in the splenic blood. He injected a solution of Urea into the blood-vessels of dogs and rabbits, and found that it was quickly followed by a decided destruction of blood-corpuscles and an increase in the fibrin. A similar result followed the injection of lactic acid into the blood, but here the change was not so remarkable. To ascertain whether or not Zimmermann, Beltrami and Lussana are right in supposing that muscular action increases the amount of fibrin in the blood, he analysed the blood of animals whose muscles had been tetanised by induction shocks till death ensued. He analysed the blood of men who died of traumatic tetanus. He analysed the venous blood of a tetanised limb, and compared it with that of a limb at rest in the same animal. Sometimes he found a slight increase of the fibrin, but just as often there was no change, and sometimes there was a diminution of it. Equally indefinite were the results of experiments undertaken to ascertain the effect of starvation upon the amount of fibrin.

COAGULATION OF FŒTAL BLOOD. Boll (see *Journ. of Anat. and Phys.* No. IX. p. 233).

INORGANIC CONSTITUENTS OF BLOOD.—Jarisch (*Wien. Med. Jahrb.* 1871, p. 14, and *Centralblatt,* 1872, No. 4).

EVOLUTION OF AMMONIA FROM PUTREFYING BLOOD. — Exner (see *Journ. of Anat. and Phys.* IX. p. 247).

COMPOSITION OF BLOOD IN CHYLURIA.—Hoppe-Seyler (*Untersuchungen,* 1871, p. 551. Abstract in *Chem. Soc. Journ.* 1871, p. 740).

Digestion.

ACTION OF SALIVA ON STARCH.—Paschutin (*Centralblatt,* 1871, No. 24) finds, 1, that the action of Ptyalin on starch is not interfered with by an accumulation of the newly-formed sugar in the fluid. As is well known, in the case of gastric juice, the accumulation of peptones interferes with the action of pepsin; 2, that Ptyaline cannot transform starch into sugar without itself undergoing some change, its power as a ferment diminishes.

SEPARATION OF DIGESTIVE FERMENTS.—Paschutin (*Centralblatt,* 1872, No. 7). The sugar-forming ferments contained in the intestinal mucous membrane of the dog can be readily separated by filtration through a clay cell, under the influence of Bunsen's gas-pump. Filtration after this manner serves also to separate the three pancreatic ferments. These may be obtained with difficulty from a watery extract of the gland, but if the gland be previously extracted by means of concentrated saline solutions, the ferments can then be readily obtained. Different salts extract the ferments in different proportions, some salts indeed extract only a single ferment; e. g. the ferment which acts on Albumen may be extracted in a nearly pure state by means of Rochelle salt, Sodium Hyposulphite, Ammonium Nitrate, &c.; the ferment that acts on starch may be extracted by Potassium Arsenate, &c., and the ferment that acts on fats may be extracted by Potassium Antimonate, Sodium Bicarbonate, &c.

GASTRIC DIGESTION.—Fick, *On Pepsin Digestion and Physiological Relations of its Products* (*Centralblatt*, 1871, No. 29). Lubavin, *On Artificial Digestion of Casein by Pepsin, and the Action of Water on Albuminous Substances* (Hoppe-Seyler's *Untersuch.* 1871; abstract by Dr Brunton in *Chem. Soc. Journ.* 1871, p. 731).

Grünnhagen, *On a New Method for estimating the Action of Pepsin* (*Pflüger's Archiv*, 1872, v. p. 203). Panum (*Nordisk Medicin. Arkiv.* 1871, III. H. 2, No. 9, *Centralblatt*, 1871, No. 51) describes his method for making Gastric fistulæ, and gives results of experiments with different kinds of Pepsin. He praises the Pepsin essence made by Schering of Berlin on Oscar Liebreich's receipt. Heintz, *On Pepsin* (*Archiv, Pharmac.* CXLVI.). Farr, *On Food Solvents* (*Med. Times and Gazette*, 1871, Vol. I.). Pavy, Excellent *Lectures on Digestion* (*Lancet*, 1871-2). Friedinger (*Wiener Acad. Bericht*, LXIV. [2], October, 1871, *Centralblatt*, 1871, No. 51) discusses the question what cells in the gastric glands form the Pepsin. This question has been considered recently by Rollett (*Centralblatt*, 1870, p. 325, and 1871, p. 373). Heidenhain (*Ibid.* 1870, p. 837, and 1871, p. 574), and Ebstein (*Ibid.* 1871, p. 81, see *Journ. of Anat. and Phys.* VIII. p. 407). Heidenhain comes to the conclusion, in opposition to Ebstein, that the older view should be adopted, to wit, that the superficial or investing cells (Rollett's adelomorphous cells) are those which produce pepsin.

Muscle.

DISAPPEARANCE OF GLYCOGEN DURING MUSCULAR WORK.—Some time ago O. Nasse discovered that during rigor mortis the amount of glycogen in a muscle undergoes a diminution. He inferred from this that during contraction a diminution in the amount also takes place. Weiss (*Wein. Akad. Bericht*, LXIV. Abth. II. July, 1871) finds that such is the case. He took a frog, and tetanised the muscles of one leg by paralysing the lumbar nerves. When the muscles were completely exhausted, he estimated the amount of glycogen in them, and also in those of the leg which had been kept in a state of rest. There was decidedly less glycogen in the tetanised muscles. In one series of experiments the loss of glycogen was 24·27, in a second, 28·24, in a third, it was 50·427 per cent.

Proceeding from these facts, he compared the amount of glycogen in the heart with that in the dorsal muscles of a dog which had been starved for forty hours, and then three and a half hours previous to its death fed on starch paste. He found that in the cardiac muscle, notwithstanding its constant activity, the per centage amount of glycogen is nearly two-thirds of what it is in the comparatively quiescent dorsal muscles (0·510 per cent. glycogen in heart, 0·7175 per cent. in dorsal muscles). Another series of experiments were undertaken to ascertain the extent to which the amount of glycogen in muscle is affected by deficient nutrition, and also by various diets. These were performed on fowls. He found that the amount of muscle-glycogen does not vary nearly so much as that of liver-glycogen. Insufficient food, or the absence of Carbohydrates diminishes both, but it diminishes the liver far more than the muscle-glycogen. He found indeed that in one case after Carbohydrates had been removed from the food for three days, that the liver-glycogen had almost entirely disappeared, while the muscle-glycogen (that of the pectoral muscles was always examined) was little affected. [This seems to shew that the glycogen-muscle is not dependent on the liver for its formation.] It therefore appears that muscle-glycogen is not nearly so much affected by starvation as has been hitherto supposed. The explanation of the retention of muscular power during starvation, although that power gradually diminishes, is ascribed by Weiss to the slow exhaustion of the stock of muscle-glycogen. Brucke's method of estimating glycogen was used in these experiments (vide infra).

Miscellaneous.

INFLUENCE OF MUSCULAR EXERCISE UPON EXCRETION OF NITROGEN.—Prof. Austin Flint, Junior (*On the Physiological Effects of Severe and Protracted Muscular Exercise, with special Reference to its Influence upon the Excretion of Nitrogen*, 8vo. pp. 91, New York, 1871), communicates the results of observations made upon a celebrated pedestrian named Weston. The observations were made by a committee consisting of Professors Flint, Dalton, Doremus, Hammond and others. Weston proposed to walk four hundred miles in five consecutive days, and upon one of those days to walk one hundred and twelve miles in twenty-four consecutive hours. The committee resolved to make minute observations of everything regarding his food, excreta, weight, temperature, pulse, state of health, &c., for (1) five days previous to the walk; (2) during the five days of the walk, and (3) during five days after the walk. Weston was to eat and drink just as he pleased, while the committee registered everything. For this purpose the doings of the pedestrian were watched night and day by one of the gentlemen. This was rendered possible by the walk being performed in a covered building in New York. Judging from Dr Flint's report, the utmost care and circumspection seem to have been observed in making the observations, which in all such experiments are of a most laborious character.

The following table shews the chief results of the experiments :

Before the Walk.	Weight of Body (Nude). lbs.	Temperature. Fahr.	Pulse.	Miles Walked.	Nitrogen in Ingesta. grains.	Nitrogen in Egesta (Urea and Fæces). grains
1st day.	120·5	99·7	75	15	361·22	323·26
2nd ...	121·25	98·4	73	5	288·35	301·18
3rd ...	120	98	71	5	272·27	330·36
4th ...	118·5	99·1	78	15	335·01	300·57
5th ...	119·2	99·5	93	1	440·43	320·06
Mean		99	78		339·46	315·09
During the Walk.						
1st day.	116·5	95·3	98	80	151·55	357·10
2nd ...	116·25	94·8	93	48	265·92	370·64
3rd ...	115	96·6	109	92	228·61	397·58
4th ...	114	96·6	68	57	144·70	348·53
5th ...	115·75	97·9	80	40·5	383·04	332·77
Mean		96·3	90		234·76	361·52
After the Walk.						
1st day.	118	98·6	76	2	385·65	295·70
2nd ...	120·25	98·4	73	2	499·10	358·81
3rd ...	120·25	99·3	70	2	394·83	409·87
4th ...	123·5	98·8	78	2	641·71	382·89
5th ...	120·75	97·5	76	3	283·35	418·49
Mean		98·6	74		440·93	373·15

Previous to and after the walk the health was good. On the first day of the walk "he seemed to feel very well," but "was a little nauseated at times, but he stated that he had always more or less disturbance of that kind when he first commenced to walk." On the third day he complained very much of drowsiness (he had slept very little during the previous 48 hours). On the previous night he began the attempt to walk 112 miles in 24 consecutive hours, but he failed from want of sleep. On the morning of the fourth day he began his second attempt to accomplish this feat. In the evening he broke down—he became giddy and staggered so that he could scarcely see the track. He was compelled to abandon the attempt, and was greatly depressed at the failure. At the conclusion of the fifth day "he was in the best health and spirits." It is evident from the table above given, that during the first four days of the walk the nitrogen in the Fæces and Urea greatly exceeded that in the ingesta.

The loss of weight after the first day of the walk was not very marked. That the excretion of Nitrogen was decidedly increased during the period of muscular exertion is obvious from the table. Dr Flint ascribes this to increased waste of muscular tissue. The experiment is a very complicated one, and is likely to cause a good deal of discussion. Indeed, we think it so complicated that it is difficult to draw from it any conclusions which are calculated to give any very decided advancement to our knowledge of the part which muscular tissue takes in generating mechanical energy. Such complications as these strike us. Weston seemed to fail during the walk owing to want of sleep, and no wonder—look at the following table which we have drawn up from the experiments :

HOURS OF SLEEP.

Before the Walk.		During the Walk.	After the Walk.
1st day	7′. 30″	1′	8′. 20″
2nd ...	6′. 40″	4′. 28″	8′. 15″
3rd ...	9′	0′. 30″	8′. 50″
4th ...	7′. 15″	1′	7′. 35″
5th ...	10	9′. 26″	7′. 45″
Total	40′. 25″	16′. 24″	42′. 5″

It certainly is not surprising that he failed to walk 400 miles, but it is indeed a wonder that he walked 317·5 miles during five days with only 16½ hours sleep during the period. It appears that he could not sleep. Can Dr Flint say that the want of sleep and excitement certainly exerted no influence upon the metamorphosis of albumenoids in various tissues, such as might have increased the excretion of Urea? And as regards the food—was the amount of Carbohydrates sufficient for the production of the muscular energy? (supposing we adopt the view that these are the ordinary sources of this energy). Dr Flint makes a point of the fact that the man took what food he liked, and as much of it as he pleased. It is evident from the table that he took less nitrogenous food, but the quantity of Carbohydrates consumed is not set forth.

Judging as well as we can from Dr Flint's tables, we are inclined to think that Weston did not consume a greater but rather a smaller amount of Carbohydrates during the walk than he did before it. Parkes found in his former experiments, and again in those recently performed by him (*Proc. R. S.* XIX. 349), that if muscular work be done on an abundant diet of Carbohydrates—without nitrogenous matter—that the excretion of Nitrogen, although somewhat increased after the work is done, is not increased during its performance.

No doubt the work done by the subjects of Parkes' experiments was much less than that performed by Weston, but nevertheless the difference in the result is striking; and it makes us anxious to know how the excretion of Nitrogen may be influenced by the performance of great muscular exertion on a diet deficient in Carbohydrates. In that case is the disorganisation of nitrogenous matter belonging to the muscle or to the blood-corpuscles, or other tissue accelerated? Are albumenoids in that case seized upon to supply the pabulum for the evolution of the muscular energy? Of course we do not say that Weston's diet was during the walk deficient in Carbohydrates, although we are inclined to think it was. In conclusion, we would say that this remarkable experiment leads us to desire more information regarding the effect of *great* and *prolonged* muscular effort upon the excretion of Nitrogen. The question will not, however, be much advanced unless we can get rid of such complications as sleeplessness, &c., which hamper the above case, which nevertheless is one of great interest.

EXCRETION of NITROGEN. Seegen (*Wiener Acad. Bericht*, 1871, LXIII. [2], p. 11) concludes, from experiments on dogs, that all the nitrogen ingested does not reappear in the urine and fæces—a part leaves the body in some other way, by the skin or lungs. Voit maintained that the amount of nitrogen in the urine and fæces covers that of the ingesta. But Voit estimated the nitrogen in the flesh which the animals ate at 3·4 per cent. Seegen finds from experiments by Toldt and Novrath that in horse-flesh the nitrogen varies from 3·5 to 3·9 per cent. In different muscles of the dog it was found to vary as much as from 3·52 to 4·31 per cent. (See Abstract in *Chem. Soc. Journ.*, 1871, p. 943.)

CONSTITUTION of BLOOD and NUTRITION of MUSCULAR TISSUE Marcet (*Proc. R. S.* XIX. 465).

Bone.

COMPOSITION OF BONE.—Aeby communicates results of numerous analyses of human bones (*Centralblatt*, 1871, No. 36) and of those of the lower animals (*Ibid.* 1872, No. 7).

Weiske (*Ibid.* 1871, 39 and 1872, No. 11) concludes, from experiments upon goats, that a deficiency of phosphoric acid or of lime in the food does not cause any noteworthy alteration in the amount of these substances in the bones. In one case he subtracted these things from the food for a period of fifty days. Although they be cut off from the food they continue to be excreted however. Their source must, therefore, be the soft tissues. They may be immediately derived from the bone, but if so, the bone makes good the loss by drawing upon the supply of these materials in the soft tissues.

Milk.

COMPOSITION OF MILK.—Bogomoloff (*Centralblatt*, 1871, No. 40).

MORPHOLOGY OF MILK CASEIN.—Kehrer (*Archiv für Gynækologie*, II. 1871, p. 1); (Abstract in *Centralblatt*, 1871, No. 21).

FILTRATION OF CASEIN.—Schwalbe (*Centralblatt*, 1872, No. 5).

FUNDAMENTAL DIFFERENCE BETWEEN THE STRUCTURE OF ALBUMEN and THAT OF CASEIN.—Wanklyn (Abstract in *Journ. of Chem. Soc.* 1871, p. 837).

CONSTITUTION OF MILK AND BLOOD.—Dumas (*Archiv Sci. Phys. Nat.* [2] XLI., 105; Abstract in *Journ. Chem. Soc.* 1871, p. 838).

Urine.

ESTIMATION OF UREA.—Huefner (*Journ. für pract. Chemie, N. F.* III. p. 1; *Centralblatt*, 1871, No. 17) describes a modification of Knopp's method for estimating Urea. Knopp's method is based on the fact that a solution of Barium Hypobromite decomposes Urea and liberates its nitrogen. The amount of Urea is estimated from the quantity of nitrogen which is obtained. Huefner has invented an ingenious and simple apparatus with which this valuable process can be rapidly and satisfactorily performed. A tube open at the top capable of holding 100 CC is by means of a glass stopcock divided into an upper and lower compartment; the latter holding 10—11 CC. The upper end of the tube is fixed in a glass saucer perforated so as to permit the free end of the tube to project to some extent. The lower compartment of the tube is filled by means of a long funnel with the urine previously diluted four or five times with water. The stopcock is then turned. The upper compartment of the tube is then filled with a watery solution of Sodium Hypobromite. The saucer around its upper end is half-filled with solution of common salt, to serve as a barrier to the escape of gas. A graduated gas-tube filled with distilled water is inverted over the end of the tube containing the bromate, the edge of the inverted tube resting in the saucer covered by salt solution. The stopcock is now turned to permit the bromate to mingle with the urine, nitrogen is evolved and accumulates in the inverted gas-tube, in which its volume is at once ascertained. The Urea decomposition is over in five minutes, but even a shorter time will suffice if the lower part of the tube be placed in hot water. To know how much Urea is represented by a certain volume of nitrogen one requires to decompose a known quantity of Urea and observe the volume of nitrogen which it gives; this serves as a standard. [Ludwig highly approves of this method.]

EXCRETION OF UREA INJECTED INTO THE BLOOD.—Falck (*Virch. Archiv*, 1871, LIII. p. 282) confirms the observation that if Urea be injected into the blood of a dog it is ere long excreted by the kidneys unchanged. He gives a historical *résumé* of researches regarding the physiology of Urea.

ORIGIN OF UREA.—Geschleiden (*Studien über den Ursprung des Harnstoffs im Thierkörper*, Leipsic, 8vo. pp. 44; Abstract in *Centralblatt*, 1871, No. 40) finds no evidence of the formation of Urea in the liver; finds no more Urea in blood of hepatic vein than in that taken from vena cava, just above junction of the iliac veins.

Why the portal blood should not have been compared with the blood of the hepatic vein does not appear. That this should not have been done seems the more remarkable because Geschleiden found, as Cyon had previously done, that when the liver is excised and blood is driven through it, the amount of Urea in the blood undergoes an increase. How this is to be reconciled with Geschleiden's statement that the amount of Urea in the hepatic tissue is not greater than that of the blood generally we are unable to say. This interesting subject is still in an unsatisfactory position.

SUGAR IN URINE.—Seegen (*Centralblatt*, 1872, No. 3) states that Kühne is mistaken in saying that normal urine contains 0·1 per cent. of sugar. Seegen added 0·006 per cent. of sugar to normal urine, precipitated the urine with lead, and obtained distinct evidence of the presence of sugar with the fermentation and polarisation test. Unless he added the sugar, normal urine similarly treated gave no such evidence. He therefore concludes that if sugar be present in normal urine it must be in quantity less than 0·006 per cent. He remarks on the inadequacy of all existing tests for detecting the presence of an excessively minute quantity of sugar in the urine. Normal urine contains small quantities of reducing substances, but whether or not they consist of sugar cannot be at present determined. He remarks upon the fallacy which is apt to result from the power which uric acid has to reduce cupric oxide, and the difficulties which result from the presence of the urinary pigment during the employment of the copper test. He finds that the test is rendered far more reliable if the urine be previously filtered through animal charcoal (*Centralblatt*, 1872, No. 5). This keeps back nearly all the uric acid and the pigment. Most of the sugar escapes, but a small quantity is retained. This method cannot be adopted in quantitative estimations, for it is not possible by washing either with cold or hot water to separate the retained sugar from the carbon.

Maly (*Wien. Acad. Bericht* [2], LXIII. p. 477, *Centralblatt*, 1871, No. 52) had, however, previously observed the value of filtration of the urine through animal charcoal in applying the copper test to urine. Maly confirmed Kühne's observation that creatinine is an important disturbing element in the execution of the copper test. It does not prevent the cupric reduction, but prevents the precipitation of the cuprous oxide when the quantity of this is small. He did not find ammonia or its salts affect the reaction, nor did urea, lactic acid, oxalic acid, taurin, parabanic acid, glycocoll alloxan affect it. A solution containing uric acid to an amount equalling that in the urine had also no effect. [It is well known, however, that a strong solution of uric acid does reduce the cupric oxide.]

SOURCE OF INDICAN.—Jaffe (*Centralblatt*, 1872, No. 1) states that the subcutaneous injection of Indol is followed by a great increase of the Indican of the urine. Kühne has shown that Indol is one of the products of pancreatic digestion in the intestinal canal. The Indol is chiefly excreted in the fæces, and is the cause of the characteristic odour. Jaffe thinks it probable that a portion is absorbed and transformed into Indican, in which form it is excreted by the kidneys. If such be the case, one would anticipate that if the exit of the intestinal matters were prevented, there would be a more abundant absorption of the Indol. He had a case of fatal ileus, in which until death large quantities of Indican appeared in the urine. [This idea would, therefore, seem to be worthy of attention being paid to it.]

SULPHUROUS SUBSTANCES IN URINE.—Löbisch ("Observations on the Substances which contain Sulphur," *Wien. Acad. Bericht*, LXIII. [2] p. 488) states that all the sulphur in the urine is not the condition of a sulphate. Sulphur containing substances may be found in abundance in the alcoholic extract of concentrated urine. What their exact nature may be he does not know.

EXCRETION OF SODIUM PHOSPHATE INJECTED INTO THE BLOOD (Falck, *Virch. Archives*, 1871, LIV. 173).

KRYPTOPHANIC ACID.—Pircher (*Centralblatt*, 1871, No. 21) will have it that Thudichum's Kryptophanic Acid is only a mixture of indefinite things with definite impurities. Thudichum (*Centralblatt*, 1872, No. 6) accuses him of ignorance of his researches on this subject, and not only defends the existence of Kryptophanic Acid, but announces the discovery of another acid in urine, which he calls Paraphanic Acid C_{11}, H_{16}, N_2, O_6. He, moreover, states that he has found other acids in urine which resemble this, but these he has not yet analysed.

BILE-PIGMENT IN URINE.—Stockvis. (See *Journ. of Anatomy and Phys.* No. IX. p. 248.)

URINE AND ITS CHANGES IN THE BLADDER.—It has been stated that in the bladder the urine becomes concentrated, owing to absorption of water. Treskin (*Centralblatt*, 1872, No. 10) denies this. He tied the ureters and emptied the bladder in dogs. He then injected urine so as moderately to distend the bladder, and kept it there by tying the urethra. He found that there was a slight loss of urea, but instead of a loss of water there was a slight gain. The Chloride of Sodium was also somewhat increased.

Sweat.

EXCRETION OF UREA BY SKIN.—Deininger (*Deutsch. Arch. für Klin. Med.* 1870, VII. p. 587) describes the case of a boy five-and-a-half years old, who had Nephritis following Scarlatina. After six days of complete absence of the urinary secretion, a distinct crust of urea crystals appeared on the forehead and temples. On other parts of the skin the urea also appeared to a slight extent. On the eighth day of anuria the urine again appeared and recovery followed.

Bile.

GLYCOCHOLIC AND CHOLIC ACID.—"Contributions to our Knowledge of Cholic Acid" (Liebig, *Annalen*, 1871, Heft 3, p. 202). Method for preparing Glycocholic Acid, *ibid.* p. 286, by Gorup-Besanez (Abstracts in *Centralblatt*, 1871, p. 387).

BLUE PIGMENT IN BILE.—Ritter (see abstract in *Journ. of Chem. Soc.* 1871, p. 1204).

ICTERUS.—Golowin (*Virch. Archiv*, 1871, LIII. p. 417) states that experiments on dogs have satisfied him that if Jaundice be induced by forced retention of the bile, the bile acids which for a time appear in the urine with the bile-pigments finally disappear, although the pigments still continue. He supposes that the hepatic cells are thrown by prolonged bile retention in a condition in which they no longer form bile-acids. He thinks that this is a likely explanation of the absence of bile-acids from the urine in some cases of Icterus due to obstruction.

TEST FOR BILE-ACIDS IN URINE.—Strassburg (*Pflüger's Archiv*, IV. p. 461) adds a little sugar to urine supposed to contain bile, dips a piece of filter paper into the mixture, permits this to dry, and then touches the paper with a drop of concentrated sulphuric acid. If even 0.00003 per cent. of the acids be present, there will appear within a quarter of an hour an intense violet colour. Strassburg ascribes the great sensitiveness of modification of Petten Kofer's test to the absence of water.

ARTIFICIAL TRANSFORMATION OF BILIRUBIN INTO URINE-PIGMENT.—Maly (*Centralblatt*, 1871, p. 849) says that if one dissolve pure bilirubin in dilute caustic potash or soda, and then add to the mixture some sodium amalgam, the air being excluded, the dark non-transparent fluid becomes clear, and in two or three days it becomes yellow, or bright brownish yellow, and then hydrogen is evolved. The addition of hydrochloric acid to this causes the precipitation of a brownish red pigment. This pigment gives a dark absorption band between the lines *b* and *F* of the spectrum. Maly believes from this and other characters that it is identical with the pigment Urobilin which Jaffe (*Virch. Arch.* Band 47) separated from febrile and normal urine, and also identical with the following pigment.

A NEW DERIVATIVE OF BILE-PIGMENT IN THE FÆCES.—Vanlair and Masius (*Centralblatt*, 1871, p. 369) have found in fæces a pigment which they consider to be almost identical with Jaffe's Urobilin. They give to it the name of Stercobilin. It does not occur in bile, but appears to be formed from bile-pigment as it passes through the intestine. They suggest that a part of the Stercobilin is absorbed from the intestine and is excreted by the kidneys. [Should this hypothesis prove to be correct, it must be admitted that the absorbed Stercobilin undergoes some change before or after it finds its way into the urine, for the spectra of the two, although very similar, show nevertheless some points of difference. That of Urobilin extends a little to the right of line *F*, and does not reach line *b*, while that of Stercobilin extends exactly from line *b* to line *F*.

QUANTITY OF BILE IN MAN.—J. Ranke (*Blood-distribution and Alterations in the Activity of Organs*, Leipzig, 1871, pp. 191, *Centralblatt*, 1872, p. 90) found that a man with a biliary fistula, resulting from Echinococcus, secreted in the twenty-four hours an average quantity of 652 grms. fluid bile. He therefore secreted 0.44 grm. bile per kilo. of body-weight in the twenty-four hours—a figure which is very near that arrived at by calculations from experiments on dogs. His weight was 47 kgm. This estimation was made during days when the fæces were quite colourless.

Miscellaneous.

NEW METHOD OF PREPARING GLYCOGEN.—Brücke (*Wien. Acad. Bericht*, LXIII. [2], Feb. 1871) states that in the preparation of Glycogen the principal difficulty consists in the separation of albumenoid matters. He finds, however, that these may be completely precipitated from the glycogenous fluid by a solution of potassio-mercuric-iodide. This solution is made by precipitating solution of corrosive sublimate by potassium iodide, washing the precipitate, and redissolving it in a hot solution of potassium iodide to saturation. The following is Brücke's process for obtaining pure liver-glycogen. 1. Throw perfectly fresh liver into boiling water and boil for a short time. 2. Place it in a mortar, and after it has been completely comminuted return it to the boiling water, and let it remain there for a short time. 3. Filter and cool the filtrate rapidly by placing the vessel in snow or in a stream of cold water, &c. 4. When cold, drop in alternately hydrochloric acid and solution of potassio-mercuric-iodide until precipitation cease. 5. Stir thoroughly, let stand for about five minutes, and then filter. 6. To the filtrate add alcohol in minute quantities until a precipitate begin to appear. The precipitate is Glycogen. An excess of alcohol must not be added lest other substances be precipitated. 7. Throw the Glycogen upon a filter and wash, first with dilute, and then with 90 per cent. alcohol. 1. To render the Glycogen still more pure, extract with Ether. Glycogen prepared in this way is free from nitrogen and inorganic matter. A solution of iodine added so as to avoid excess renders it *not brown* but *red.* The iodine solution most suitable for this test is thus prepared. Shake metallic iodine in water, adding from time to time minute quantities of potassium iodine until the solution becomes of a pale sherry tint.

The above process may be employed in the quantitative estimation of Glycogen, but here it is needful to be very careful regarding the precipitation by alcohol (6 *supra*). Brücke obtained the most accurate results by adding alcohol until it formed 60 per cent. by volume of the fluid into which it was poured, and by then washing the precipitate with alcohol and glacial acetic acid.

The same process serves for the preparation of Glycogen from muscle. The comminution of muscle is more difficult than that of liver, so it is advantageous to bruise it in a mortar with coarse sand which has been well heated. The existence of Glycogen in the blood is disputed. Nasse denies the existence of all amyloid matter in the blood. Sanson found a considerable quantity of Glycogen in blood. Brücke has found in blood a small quantity of a substance which is rendered red by solution of iodine, but owing to the minute quantity he cannot say whether it was Glycogen or Dextrin.

The above Glycogen process serves also for the separation of Dextrin free from nitrogenous matter.

In the cases of the spleen Brücke obtained a distinct Glycogen reaction. He ascribes this to the Glycogen contained in the muscular fibres of the blood-vessels. He also found small quantities of Glycogen in the kidney. Very doubtful indications were obtained regarding its existence in the mammary gland when examined. This upsets the hypothesis that Glycogen is stored up in the gland in order to give rise to lactose.

A solution of Glycogen, prepared as above, rotates the plane of polarisation to the right. Its spectrum is characterised by nothing more than a general absorption, least marked in the red. Even dilute "solutions" of Glycogen are opalescent. This seems to be owing to the particles of Glycogen being not really dissolved but merely swollen up and suspended.

RESEARCHES ON ANIMAL STARCH.—Dareste (*Comptes Rendus*, LXXII. p. 845; Abstract in *Journ. of Chem. Soc.* 1871, p. 838).

BEHAVIOUR OF ALBUMINOUS MATTERS AND FERMENTS WITH PHENOL.—Zapolsky (*Hoppe-Seyler's Untersuch.* 1871, p. 557; Abstract in *Chem. Soc. Journ.* 1871, p. 842).

PUTREFACTIVE PROCESSES AND DISINFECTION.—Pasteur's view that fermentation is due to the immediate action of organisms is regarded by Hoppe-Seyler (*Untersuch.* 1871, p. 561) as untenable. He maintains that fermentation results from the action of substances which are not organisms. He admits, however, that a ferment cannot renew itself, but that an organism is necessary for the formation of a new portion of ferment, and that generally fermentation, formation of new ferment and production of new organisms proceed *pari passu.* That the ferment is distinct from the organisms that give rise to it, he maintains from the fact, that a certain amount of phenol and heat can in some cases kill the organisms without destroying the ferment, e.g. the addition of 0·5 per cent. of crystallised phenol to mixtures of yeast and hydrocele fluid kills the organisms, but does not stop the decomposition of albumen. Generally speaking, if a fluid containing a ferment be heated, the organisms perish at a temperature below that which is necessary to destroy the ferment. The alcoholic fermentation, however, is exceptional. In this case the organisms and the ferment are both destroyed by the same temperature. Regarding the use of phenol as a disinfectant, he says 1 per cent. of this substance will destroy minute organisms, but 2 per cent. is necessary to arrest putrefactive changes. Sulphurous oxide gas appears to be the most effective agent for destroying germs in the air.

GELATINE PLATES FOR SPECTROSCOPY.—For the demonstration of absorption spectra of soluble pigments, Lommel (*Pogg. Annalen.* CXLIII. p. 656) recommends thin sheets of gelatine. He impregnates the gelatine paper with the pigment and then places them between two glass plates to keep out dust, &c. All shades of depth in the spectra may be obtained by overlapping pieces of the gelatine paper so as to form an arrangement resembling a staircase. In this way one can examine the spectra given by 1, 2, 3, 4 layers of the coloured gelatine, and so on.

CHEMICAL COMPOSITION OF PUS.—Hoppe-Seyler and also Miescher (*Hoppe-Seyler's Untersuch.* 1871; Abstracts in *Chem. Soc. Journ.* 1871, pp. 742 and 744).

THE NUCLEAR STRUCTURES IN THE YOLK OF THE HEN'S EGG.—Miescher (*Hoppe-Seyler's Untersuch.* 1871; Abstract in *Chem. Soc. Journ.*, 1871, p. 746).

PROTEIDS.—Hlasiwetz and Habermann (*Ann. Chem. Pharm.* CLIX. p. 304) discuss the genetic relations between Proteids and Carbohydrates (Abstract in *Chem. Soc. Journ.*, 1871, p. 1069).

MUCIN OF SUBMAXILLARY GLAND, PARALBUMEN.—Obolensky (Pflüger's *Arch.* IV. p. 336; see Abstract in *Centralblatt*, 1871, p. 825).

LIEBIG'S EXTRACT.—Weide (*Centralblatt*, 1871, p. 304) constantly finds in Liebig's Extract a hitherto unknown nitrogenous substance C_7, H_8, N_4, O_3 closely related to theobromine C_7, H_8, N_4, O_2 and Caffein C_8, H_{10}, N, O_3. He thinks that the action of the extract is partly due to this substance.

WASTING OF THE TISSUES DURING STARVATION.—Seegen (*Wiener Acad. Bericht*, LXIII. p. 429) made observations on a woman who, on account of some gastric affection, took as her sole nourishment 35 grm. of fresh cow's-milk daily for twenty-four days. After fourteen days of this diet, the quantity of urine and urea were estimated. The 35 grm. milk introduced to the organism 0·29 grm. N. During twelve days of observation the quantity of nitrogen thus introduced was therefore 3·4 grm. In the same twelve days 106·9 grm. of urea were excreted. This contained 46·4 grm. nitrogen. This quantity represents 299·3 grm. of albumen. In the same period 55 ccm. of water were taken daily, and 185 ccm. excreted by the kidneys daily. When more abundant nitrogenous food was given, the amount of nitrogen excreted was not increased for a considerable time. The nitrogen was stored up in the body to make good what had been lost. Seegen concludes that when the body must nearly altogether feed upon itself it uses only a fifth of the albuminates consumed when the ordinary nourishment is given.

CHEMICAL CONSTITUENTS OF TESTIS.—Treskin (Pflüger's *Archives*, V. p. 122).

DR BRUNTON'S AND DR FERRIER'S REPORT.

Nervous System.

Influence of the Posterior Roots of the Spinal Nerves on the Anterior.—G. Heidenhain (*Pflüger's Archiv*, IV. 435—453) has investigated the question as to whether the posterior roots really influence the anterior. He took special care to insulate his electrodes from all except the posterior roots themselves. With these precautions he found that section of the posterior roots exercises no appreciable influence on the irritability of the anterior. He likewise found that there was no increase of tone when the sensory branches of a mixed nerve were irritated; a result at variance with the idea that the irritability of the anterior roots is kept up by a constant action of the posterior. Neither was any result obtained when the sensory nerves of the skin were irritated by a weak acid not sufficiently concentrated to produce muscular contraction as long as the brain and cord were intact, but which was strong enough to produce reflex action when the cord was divided below the medulla. Removal of the cerebrum, which, according to Cyon, diminishes the irritability of the anterior roots, did not cause any such effect in the experiments made by Heidenhain. He therefore entirely denies Cyon's statements on this subject.

Regeneration of Nerves. — Vulpian (*Revue Scientif.*, Jan. 6, 1872, p. 668) has made numerous experiments on the regeneration of nerves after lesions. The alterations which took place in the nerves after cutting, tearing or transfixing with a needle dipped in acetic acid, or oil, or turpentine, were all alike; but regeneration occurred more quickly when the nerve was torn than when it was cut.

Influence of Nervous Lesions on Muscular Contractility and Nutrition.—Vulpian (*Revue Scientif.*, 1871-2, pp. 668 and 691) finds that muscular contractility is diminished more or less, but never completely abolished, by lesions to nerves. The diminution of contractility is not much affected by the nature of the lesion, but it is greater after excision than rupture. When the electric irritation is applied to the denuded muscle, though not when it is covered with skin, little or no difference can be observed between the action of constant and interrupted currents.

Alterations in the nutrition of a limb are especially marked after simple section of a nerve. When the sciatic of a dog was cut, and the other tied, ulceration of the toes occurred on that side where the nerve had been cut, but none where it had been ligatured. Injury to the sciatic nerve, of whatever nature, invariably produced epilepsy in guinea-pigs. Transfixion of the vagus by a needle dipped in acetic acid produced the same effects as section of the sympathetic.

INNERVATION OF THE LACHRYMAL GLAND.—Wolferz (*Inaug. Dissert. Dorpat*, 1871, *Centralblatt*, No. 53, 1871) states (1) That the lachrymal branch of the 5th is the proper secretory nerve of the gland. Irritation of this nerve causes increased secretion of tears. (2) Irritation of the subcutaneus malæ has a similar result, but less marked. (3) After section of the n. lachrymalis reflex secretion can no longer be caused through the trigeminus, but it may by means of the optic nerve. (4) Irritation of the sympathetic gives sometimes positive and sometimes negative results. (5) After section of the lachrymalis and sympathetic, a paralytic secretion of tears goes on continuously. (6) Curara causes increased flow of tears even after section of the lachrymal, but the amount is less than on the sound side.

ON THE VIOLET SENSORY NERVES.—Preyer (*Centralblatt*, No. 8, 1872) has made an ingenious use of a patient affected with monocular green blindness in determining that violet is the third fundamental colour of the spectrum. The patient, who was under the care of Woinow, saw colours differently with the right and left eye. By means of Maxwell's discs it was found that she was totally green-blind of the right eye. She was therefore tried with the violet and blue of the spectrum with the following purpose. If the perception of blue is due to simultaneous stimulation of green and violet sensory elements of the retina, blue should appear violet to a green-blind eye. If, on the other hand, blue is the fundamental colour, then such an eye should recognise blue as such. The experiment proved, that though blue and violet were qualitatively distinguished, violet being 'much prettier' than the blue, yet both colours in the green-blind eye were described as reddish lilac.

Hence from this experiment it appears that violet, and not blue, is the third fundamental colour of the spectrum. That this was probably so, Young, and more recently Helmholtz, had expressed.

THEORY OF NEGATIVE OCULA SPECTRA.—Adamük and Woinow (*Von Gräfe's Archiv*, XVII. I. 135—157) shew that there is a difference between the colour spectra in the central and peripheric parts of the retina, just as the perception of colour differs in these parts. Their conclusions agree with former observations on the red and green colour-blindness of the peripheric portions of the retina. Two pieces of green paper on a grey ground were placed at the distance of the middle point of the eye, and observed with the optic axes parallel. These gave one intense green complete image and two half images, which were less green and more yellowish the nearer the objects were brought to the eye. The half images were those of the peripheric portions of the retina, and of course these became more peripheric the nearer the object approached the eye. Red papers under the same conditions appeared orange, brown, or black; rose-coloured papers appeared violet up to blue. When the green pieces of paper were removed after a period of observation, then three spectra were seen, the central of a rose-red colour, and the two outer ones blue. A more exact experimentation and localisation of the image on the retina shewed that red gives in the centre a green spectrum, in the periphery a blue, in the outermost margin a white. Violet gives in the centre a yellowish green spectrum, in the outer portions orange-yellow, still farther outwards yellow, and in the outermost margins colourless. The spectra of orange, yellow and blue gave the same spectra in all parts of the retina.

The spectra seem, therefore, to be complementary to the colour of the pigment in the different parts of the retina.

MECHANISM OF ACCOMMODATION.—R. E. Dudgeon (*Pamphlet*, p. 19) believes that the accommodation of the eye from distant to near vision is effected not, as usually believed, by an increase in the convexity of the surfaces of the crystalline lens, but by a slight rotation of the lens itself from without inwards, the focus of the lens being shortened by this movement. The contraction of the pupil during this act corrects any tendency to the formation of a blurred image on the retina by cutting off the more obliquely impinging, and therefore superfluous, rays of light.

PERCEPTION OF SOUND. — Urbantschitsch (*Centralblatt*, No. 8, 1872) describes some curious and as yet unexplained phenomena connected with the sense of hearing. When a vibrating tuning-fork is passed before the ear, there are two points at which the vibrations cease to be heard. When the tuning-fork is held upright, and moved backwards from the inferior margin of the zygomatic arch, so that the upper end of the instrument is opposite the lower margin of the tragus, and if it be carried backwards to the occiput at the same level, the vibrations become intercepted at two points. One of these deaf spots lies at the lower end of the tragus, the second occurs at the point of intersection of the helix with the above-mentioned line. In front, behind and between these points, the perception of sound is quite distinct, while on gradually approaching these points the sounds become weaker, and gradually again increase in intensity. If the tuning-fork is held in a horizontal position and moved vertically upwards from the lobe of the ear, this phenomenon repeats itself in the region of the crista helicis. The phenomena remain the same whether the fork is brought nearer or removed from the ear. At a certain distance, however (8—10 cm.), the sounds are heard uninterruptedly. More exact investigation proved that the deaf spots have the form of two triangles, of which the one is directed forwards and upwards, the other backwards and downwards. The phenomena described remain the same whether the ear be covered by the hand or filled with wax, and even when the membrana tympani is destroyed.

FUNCTION OF THE LARYNGEAL NERVES.—Navratil (*Berlin. Klin. Wochensch.*, No. 33, 1871), from his experiments on dogs and cats, comes to the conclusion that the superior laryngeal nerve is entirely free from motor fibres, and that the crico-thyroid is not supplied by this nerve. He likewise states, in opposition to Bernard, that the spinal accessory has no influence whatever on the laryngeal muscles.

INFLUENCE OF NERVES ON NUTRITION.—Dr Joseph (*Centralblatt*, No. 46, 1871) has made experiments on the question of trophic nerves in the limb of the frog, and comes to the following conclusions. When the nerve of the leg is cut sensibility and motion is lost. Dilatation of the vessels occurs, but this disappears after forty-eight hours, and the circulation again becomes normal. The wasting of the leg which follows section of the nerve is entirely due to inactivity, and not to any direct influence of the nerves on nutrition. Wounds heal in the same time, and in the same way, whether the nerves be cut or not. After death the muscles of the leg in which the nerves have been divided retain their irritability generally longer than those of the sound side.

In all these experiments especial care was taken that the animals were fed, and also in section of the nerves the leg itself was left intact as much as possible.

ELECTRICAL DISCHARGE OF THE TORPEDO. — Marey (*Comptes Rendus*, LXXIII. 918—921) seeks to determine the time required by a stimulus applied to the nerve of the electric organ of the torpedo to set free the discharge. The time was recorded on a pendulum myographion by means of the contraction of a frog's muscle thrown into action by the discharge. When the period of latent stimulation of the frog's muscle was subtracted, the remaining part of the tracing indicated the time required to cause the discharge. He found it to be $\frac{1}{60}$th second. This is the time of the latent stimulation, as the portion of the nerve between the electrodes and the organ was so small as to be quite disregarded. In another communication (*Comp. Rendus*, LXXIII. 958—961) Marey determined the duration of the electric discharge. This was done by forming a complete circuit to the nerve of the recording frog's muscle only once in $\frac{1}{200}$th second. If the circuit were formed too soon after stimulation of the nerve of the organ no contraction ensued. After a certain period contraction occurred, and after a still longer period no more contractions occurred. The whole duration of the discharge was estimated at $\frac{1}{14}$th second. This corresponds to the duration of a muscular contraction, so that this appears a new confirmation of the analogy between the electric organ and muscle.

CENTRAL INNERVATION OF THE VASCULAR SYSTEM.—R. Heidenhain (*Pflüger's Archiv*, IV. 551—558) questions the statement made by Cyon, that irritation of sensory nerves causes sinking of the blood-pressure in animals narcotised by chloral, or whose cerebrum has been removed. He traces the effect to changes in the respiratory movements. The effect mentioned by Cyon is never observed if the animals have been curarised. It is observed that when a sensory nerve is irritated during the period of retarded respiration, a series of rapid respiratory movements are made. The sinking of the blood-pressure coincides with these. If, however, instead of irritating the sciatic, the electrodes are applied to the central end of the vagus, then the respiration ceases, and generally a rise in the blood-pressure results, instead of sinking. Heidenhain finds that chloral causes sinking of the blood-pressure and slowing of the heart. This is due partly only to irritation of the vagi, for the effects are seen even when both vagi are cut. The action is therefore partly to be explained by weakening of the heart and of the vaso-motor centre.

IRRITATION OF THE VASO-MOTOR CENTRE IN THE FROG.—Kessel and Stricker (*Stricker's Med. Jahrb.*, 1871, p. 102) find that when the medulla oblongata of the frog is irritated by an interrupted current passed through two electrodes stuck into it, the vessels in the web of the foot contract, and the circulation is first slowed and then stops. Sometimes this does not occur till the irritation has been applied at intervals for some time. The veins occasionally contract more than the arteries, the contraction being so great in one case that the lumen of the vein was nearly obliterated. The capillaries were sometimes observed to contract in parts.

POSITION OF THE VASO-MOTOR CENTRE IN THE FROG.—Soboroff (*Stricker's Med. Jahrb.*, 1871, p. 449) confirms the observation of Kessel and Stricker. The contraction of the vessels and stoppage of circulation in the frog's web, on irritation of the medulla, is not due to the irritation causing stoppage of the heart by acting on it through the vagus, as it produces the same effect on the web after the vagi have been divided. The vessels of the mesentery are unaffected by irritation of the medulla. When the electrodes are inserted into the medulla behind the occipital bone, contraction of the vessels of the web can generally be produced in Rana temporaria, but not in Rana esculenta. When the electrodes are inserted through the posterior part of this occipital bone, contraction can be produced in both kinds of frog. The vaso-motor centre in frogs thus seems to extend over some space. The vaso-motor centre acts on the vessels of the web through the sciatic, for when this nerve was cut on one side and the medulla irritated, the circulation in that foot remained unaffected when the vessels on the other side became contracted.

CAUSE OF DIABETES.—Cyon and Aladoff (*Mélanges Biologiques* and *Bull. de l'Acad. Imp. de St Pétersbourg*. VIII. 91) shew that Eckhardt's hypothesis, that diabetes after section of the last cervical or a thoracic ganglion of the sympathetic is due to irritation of the ganglion is erroneous, for diabetes occurs when the fibres proceeding from the last cervical or first dorsal ganglion are divided, although the ganglia themselves are not touched. When the nervous filaments which fall along the vertebral artery from the spinal cord to the last cervical ganglion, or the two fibres which connect this ganglion with the first dorsal enclosing the subclavian artery in their passage from one ganglion to another and forming the annulus of Vieussens, are cut, diabetes takes place with the same certainty as when all the fibres are cut; but all the others may be cut without diabetes occurring, if these fibres be left intact. On irritating the fibres forming the annulus of Vieussens, the liver becomes paler and bleeds less freely when cut. When a T cannula is placed in the hepatic artery, or portal vein, and the annulus is irritated, the blood-pressure rises 30—70 mm. in the artery and 10—12 in the portal vein. This is shewn to be due to contraction of the branches in the liver by compressing the artery on the distal side of the cannula, so that alteration in the lumen of its branches can no longer affect the pressure in it while any influence of central origin would act as before. When the artery is compressed in this manner and the annulus irritated, no alteration of the pressure in the artery ensues. Division of both annuli produced dilatation of the hepatic artery and fall of blood-pressure in it. The altered pressure in the portal vein during irritation of the annulus is due, they think, indirectly to the change of pressure in the artery. Diabetes then, after section of nerves, is due to an increase in the circulation in the liver from dilatation of its vessels. The vasomotor nerves of the hepatic artery pass out from the spinal cord along the vertebral artery to the last cervical ganglion, from it through the annulus of Vieussens to the first dorsal; then down the gangliated cord and splanchnics to the liver. It would therefore be expected that division of the chord and splanchnics would cause diabetes, but Cyon finds, like Eckhardt, that not only does section of these parts not produce diabetes, but that it prevents its occurrence when the annulus is subsequently divided or the fourth ventricle irritated, although it does not remove diabetes when this has been previously induced. The reason of this, Cyon supposes to be, that when the splanchnics or gangliated cord are cut, in which the vasomotor nerves of the intestines as well as of the liver are contained, the intestinal vessels become so dilated and blood accumulates in them to such an extent, that there is either too little blood remaining or the pressure is too low to increase the circulation in the liver above the normal, although its vessels are dilated. When the hepatic vessels, however, are dilated first, either by division of their nerves, or irritation of the fourth ventricle, the blood continues to flow through them and diabetes is not arrested, although the vasomotor nerves of the intestine be subsequently divided and the intestinal vessels dilated.

Circulation and Respiration.

INFLUENCE OF BLOODLETTING ON THE CIRCULATION AND TEMPERATURE.—Gatzuck (*Centralblatt*, No. 53, 1871) from his experiments on dogs arrives at the following results in reference to this subject. Venesection diminishes the rapidity of the blood-stream as determined both in the carotid and femoral. A venous or arterial hæmorrhage from the anterior extremities has a greater influence on the rapidity of the blood-stream than a similar one from the hinder extremities. The alteration of the mean rapidity of the blood-stream is dependent on the amount of blood let. The mean blood-pressure sinks under the influence of blood-letting, although cases occur in which it remains unaltered or even rises. These variations depend both on the amount of blood taken and on the rapidity with which it flows from the cut vessel. After blood-letting the alteration both of velocity and blood-pressure speedily returns to the normal. With the diminution in velocity of the blood-stream, and in the amount of arterial tension, there is usually a quickening of the pulse. When the blood-letting is copious and rapid there is observed a weakening of the heart-sounds, especially of the second. In consequence of the abstraction of blood there is a fall of temperature, which amounts to 1—2° C.

RELATION OF HEART'S ACTION TO PRESSURE.—Blasius (*Verhand. d. Würtzb. phys.-med. Ges.* N. F. II. 49—99), under the direction of Fick, has sought to determine the absolute amount of work done by the frog's heart, as well as its relation to different degrees of pressure. The apparatus employed was essentially that of Coats and Ludwig.

The first set of experiments proved that the work of the heart, which is directly proportional to the arterial pressure, and inversely proportional to the time necessary to expel a given quantity of fluid, increases with increased resistance, just like other weighted muscles. At a certain pressure, however (44 mm. mercury), aortic insufficiency occurs. The work of the heart can still, however, be determined by observing the diminution in volume, read off by the degree of sinking of the fluid in which it is immersed. As regards the variations in the arterial and venous pressure, it was found that when the in-flow pressure was kept constant, increase of the arterial tension caused at first a rapid and subsequently a gradual increase of the heart's action. Beyond this the action diminished. The maximum corresponded generally to 30—40 mm. mercury. When the arterial tension is kept constant, and the venous or in-flow pressure varied, it is observed that the heart ceases to act as soon as the in-flow pressure equals the arterial. When the in-flow pressure is diminished, the heart's action is intensified, reaches a maximum, and again ceases when the venous and arterial pressure become equal.

The author confirms the observations of Cyon regarding the influence of temperature. The curve representing the action of the heart for individual contractions, when the in-flow pressure is constant and the arterial variable, rises the more abruptly, and reaches the greater height the lower the temperature, and *vice versâ*. The relations are different when the influence of temperature is reckoned, not for the individual contractions, but for the amount of work done in a given time. This is due to the influence of temperature on the number of pulsations. In this case the action of the heart at 20° C. is three times as great as at 3° C., and twice as great as at 8·5° C. When the temperature remains constant, variations in the in-flow or arterial pressure have little or no influence on the frequency of the pulse. When the in-flow pressure remains constant, while the temperature and arterial pressure vary, then the curve of the heart's action rises more rapidly to a maximum the higher the temperature. The same result follows variation in the in-flow pressure while the arterial remains constant.

CIRCULATION IN THE BRAIN.—In the *Centralblatt* (No. 45, 1871) Bernstein gives an account of recent investigations on this subject by

Jolly and Pagenstecher, which are of great interest in reference to the normal and abnormal conditions of cerebral action. Jolly determined the brain-pressure by placing a manometer within the skull. A positive pressure was always observed, which rose slightly with each pulse beat. It rose considerably with each expiration and sank with each inspiration. Increase of blood-pressure likewise caused increase of the brain-pressure; but the two do not run quite parallel to each other. The brain-pressure soon reaches a maximum and is not further increased by injection of more fluid into the carotid. Compression of the jugular vein greatly raises the brain-pressure; compression of the carotid exerts but little influence. Irritation of sensory nerves causes a rise in the brain-pressure; but this is due to increased respiratory movements. Irritation of the sympathetic raises the brain-pressure, irritation of the vagus is not followed by any constant results. Irritation of the depressor seems to have little or no influence on the vessels of the pia mater. It would appear that the normal circulation is more speedily restored in dogs than in man; for ligature of the carotid in them seems to have little effect, while in man, as is well known, it is frequently followed by paralysis. The circulation in the one carotid is quite independent of that in the other.

In asphyxia the brain-pressure undergoes considerable alteration. So long as the heart continues to beat the pressure rises. Then follows a slow and continuous decrease, and complete anæmia of the brain ensues. The experiments of Pagenstecher consisted in injecting between the dura mater and bone a melted mass of wax and lard, under a pressure varying from 80 to 120 mm. of mercury. After the death of the animal the amount of wax was compared with the capacity of the skull. The results differed with the amount of wax injected and are divided into four groups. In the first group the symptoms were somnolence, great depression of psychical activity, and general muscular debility. In the second group, in addition to the somnolence there were hemiplegic paralyses. The third group consisted of experiments in which death ensued in a few hours with comatose symptoms. These could be partially relieved by again scooping out the wax. The symptoms of compression of the brain are due to compression of the blood-vessels. In order to cause death the pressure must be 180 mm. of mercury, i.e. must equal the blood-pressure. A small quantity of material can be injected without giving rise to symptoms of compression. This is in the mean 2·9 per cent., and in the maximum 6·5 per cent. of the whole contents of the skull. The injected masses correspond in all respects to the effusion following rupture of the middle meningeal artery in man. If, therefore, the skull capacity in man be taken as 1300—1430 cubic inches, it would be necessary to have a mean of 37·7—40·6 cubic inches of blood, or a maximum of 84·5—90 cubic inches, in order to produce symptoms of compression.

The animals operated on (dogs) always exhibited manifest signs of pain during the injection, due probably to the separation of the dura mater from the bone. Violent epileptiform convulsions and general cramps were observed. Their cause seems to be the rapid changes of pressure. The pupils also exhibited change which varied in the different groups. There were observed (1) Moderate and transient contraction of the pupil on the operated side (groups 1 and 2); (2) Equal contraction of both pupils, of short duration (group 2); (3) Complete dilatation of the pupil on the operated side (groups 2 and 3); (4) Equal dilatation of both pupils. The pulse-frequence was not in general altered; only in deep sopor and coma there was slowing of the pulse for some little period. The respiration was altered only when the compression was great. In such case the respiratory movements became irregular and slower. The temperature sank in most cases immediately after the injection 0·5° C, and then rose again if the symptoms of compression were not very urgent. If the compression were great the temperature sunk till death ensued.

UNRHYTHMICAL ACTION OF THE HEART.—R. Heidenhain (*Pflüger's Archiv*, v. 143—153) describes a peculiar arhythmic of the heart, which ensues on irritation of the medulla oblongata of curarised dogs after section of the vagi. The first effect of the irritation is to cause a rise in the blood-pressure followed by increased frequency of the pulse. When the pressure rose above 250 mm. an irregular rising and sinking of the kymographic curve ensued, between which irregularities normal pulse-curves occurred. These correspond to what has been termed *delirium cordis*. After section of the motor-nerves of the heart the irregularity still continued to occur. It was, therefore, due to exhaustion of the motor apparatus, or to irritation of inhibitory centres. That it is not due to exhaustion is shewn by the fact that the irregularity ceases to be observed when the irritation of the medulla is repeated several times. That it is due to irritation of inhibitory nerves appears probable from the fact, that when the blood-pressure was raised artificially, and the cut vagi at the same time irritated, a similar irregularity occurred. Even after atropia was administered the same irregularity occurred. This shews that the atropia must paralyse centres different from those whose irritation causes the arhythmic of the heart.

INFLUENCE OF THE NERVOUS SYSTEM ON ABSORPTION. Goltz (*Pflüger's Archiv*, v. p. 53) has performed some most interesting experiments on this subject. He paralyzes two large frogs with curare, destroys the brain and spinal cord in one, and suspends them both with their feet downwards. He then cuts the aorta across, close to the heart, and the blood flows freely from the frog whose brain and spinal cord are intact, while not a drop comes from the one in which they have been destroyed. When a 1 per cent solution of NaCl is then injected into the lymph sac under the skin of the back of each, a large quantity is absorbed by the frog whose nervous system is uninjured, passing into the circulation, and drops from the cut aorta. The blood which at first flowed from the vessel therefore gradually becomes paler, and is at last replaced by a colourless liquid which, however, still possesses the power of coagulation. At the same time the fluid in the lymph sac diminishes in proportion to the amount absorbed. The fluid which remains in the sac contains fibrinogenic substance. In the frog whose brain and spinal cord have been divided no absorption whatever takes place, not a drop of fluid issuing from the aorta, and the fluid in the lymph sac remaining undiminished.

The secretion from the skin is also stopped by destruction of the spinal cord, so that it becomes smooth, dry and discoloured, while in the other frog it is covered, especially on the back, with a copious secretion. When blood is injected into the lymph sac instead of water, it is hardly absorbed at all.

The reason why no blood flows from the aorta of the frog whose brain and spinal cord have been destroyed, although its heart continues to beat, is, as formerly pointed out by Goltz (*Virch. Arch.* Bund 29), that the tone of the intestine vessels is lost, and the blood which ought to circulate remains stagnant in these vessels, and especially in the intestinal veins, which are widely dilated.

When the cord is left intact absorption will take place, and the vessels are not paralyzed, although the brain be destroyed. Goltz therefore thinks that the centre, both of the vaso-motor nerves, and nerves causing absorption, is not confined to the medulla oblongata in the frog, but extends to the spinal cord.

When the power of the nervous centres is increased by irritating the cord, either directly by an induced current, or reflexly by irritating their sensory nerves, the rapidity of absorption is increased. The increase in absorption, as measured by the quickness with which the fluid drops from the aorta, begins some time after the stimulus has been applied, and lasts for some time after it has been removed. The stimulus only increases the rapidity of absorption, but not the absolute amount of fluid absorbed, so that the same quantity will be absorbed by two frogs, one of which is left to itself, and the other stimulated till death has occurred. Goltz formerly observed that vaso-motor paralysis and dilatation of the vessels of the body could be produced by striking the intestines, and he now finds that paralysis of the absorbing nerves of the body can be produced in the same way.

The rapidity of absorption then increases or diminishes, *pari passu*, with the activity of the vaso-motor nerves, and the contraction of the vessels. Goltz does not believe, however, that absorption is due to the contraction of the muscular walls of the vessels, but to the epithelium which lines them taking up the fluid outside, and pouring it into them just as the cells of the salivary gland pour fluid into its duct. The whole blood and lymphatic vascular system might thus be looked upon as one huge gland, the epithelial cells lining the vessels corresponding to the glandular cells and their lumen to the duct. The nerves which cause absorption would correspond to the secreting nerves of the gland. According to this view the vessels receive two kinds of nerves: one, the vaso-motor, which cause contraction of their walls, and the other absorbent, which cause the epithelium to take up fluid from the tissue and pour it into the vessel.

He makes this hypothesis because a tonic contraction of the vessels under the influence of vaso-motor nerves might cause expulsion of the fluid they contained, but could not keep up a continuous flow, and a rhythmical contraction under the same nervous influence might cause fluid in the vessels to flow onwards, but would not cause fluid outside to enter them, unless it entered the vessel by open pores. He considers that the fluid is absorbed by diffusion, and not by means of open pores, because blood is not absorbed while salt solution is, and he does not see why diffusion should take place more quickly into a vessel tonically or rhythmically contracting, unless in the way of secretion.

Not only does absorption into the vessels take place more slowly when the central nervous system is destroyed, but fluid exudes more quickly out of them.

The absorption of fluid from the stomach and intestines is influenced by the nervous system in a similar manner to that from the lymph sac. When the brain and cord are destroyed and the circulation stopped, fluid exudes much more easily into the abdominal cavity from the intestine, while in animals with intact nervous centres under the same conditions no ascites occurs.

TEMPERATURE IN THE RIGHT AND LEFT VENTRICLE.—In the *Centralblatt*, No. 4, 1872, Rosenthal gives an abstract of the recent researches of Körner and Heidenhain on the subject. They both confirm the old view expressed by G. Liebig and Bernard, that the temperature of the right ventricle is higher than that of the left. In only one case the temperature was the same. In most cases the difference lay between 0·1° and 0·3°. In some cases the difference was 0·5°—0·6°. Respiration has no effect on this difference between the two ventricles. In artificial respiration on curarised animals, the difference became less, but this was due to sinking of the temperature of the blood by alteration of the circulation. The cooling influence of the inspired air is thus counteracted before it reaches the blood in the lung capillaries. The difference is not to be attributed entirely to constant difference in temperature between the arterial and venous blood. They found that a considerable share of the effect is due to the wall of the heart itself. This is most marked in the right ventricle, which has a higher temperature than the left ventricle, owing to its proximity to the diaphragm and the warmer abdominal viscera. This was proved by placing a bladder filled with cold water under the diaphragm. When this was done, the temperature of the right ventricle sank below that of the left. The same influence of the abdominal viscera is seen during asphyxia. In this case the temperature sinks in the right ventricle, but again increases after death, due to post-mortem changes in the abdominal viscera.

INFLUENCE OF INJECTION OF FREE FIBRINOPLASTIC SUBSTANCE INTO THE VEINS.—Schiffer (*Centralblatt*, No. 10, 1872) has made experiments in reference to the statement of Naunyn, that injection of blood dissolved by freezing and thawing into the vessels causes coagulation and death, owing to the amount of free fibrinoplastic substance. A similar explanation is given by Ranke of the effects of injection of bile-acids into the blood. If this be the case, the non-coagulation of the blood in the vessels would be capable of explanation without assuming an influence exerted by the walls of the vessels. The phenomenon would be sufficiently explained by supposing that the fibrinoplastic substance remained in the blood corpuscles themselves. Experiments made by Schiffer would seem to shew that the case does not so easily admit of explanation. He found that though frequently unsuccessful, yet thawed blood might be injected into the jugular vein of animals without producing any bad effect. In dogs he found, after injection of blood, the colouring matter of which had been set free (lackfarbenen Bluts), none of them suffered. The hæmoglobin was always rapidly passed off by the kidneys. He concludes from his other experiments that no coagulation of the circulating blood ensues from the injection of even large quantities of free fibrinoplastic substance into the vessels.

NOTES ON THE PHYSIOLOGY OF THE RESPIRATORY MOVEMENTS AND PULMONARY CIRCULATION.—Liebermann (*Wien. Med. Zeit.*, No. 5, 1872) describes an ingenious method of shewing that the dilatation of the air-vesicles of the lungs, and the act of respiration, is to a certain extent dependent on the filling of the capillaries with blood. For this purpose he introduced one ox-bladder within another and stitched the walls of the two so together as to leave between them a canalicular network, at the beginning and end of which tubes corresponding to the pulmonary artery and pulmonary veins were inserted. The mouth of the inner bladder was tied on a glass tube to represent the trachea. The heart was represented by another bladder filled with oil, which was propelled into the canal system. After a few contractions the collapsed walls of the vesicle gradually separated from each other, and the air rushed in by the tube with a distinct murmur, until the bladder became completely expanded. He thinks that the same process takes place in the air-vesicles of the lungs, and thinks that this affords explanation of the fact that even in the deepest expiration the lungs still contain air. This he attributes to the action of the heart filling the capillaries, and keeping up, therefore, a dilating effect on the vesicles not counteracted by the strongest expiratory efforts.

THE VOLUME OF THE EXPIRED AIR UNDER DIFFERENT CONDITIONS.—Leichtenstern (*Zeitsch. f. Biologie*, VI., 197—236; *Centralblatt*, No. 43, 1871) confirms the observations of Rosenthal, that there is no diminution of the volume of expired air after section of the vagi. After artificial one-sided pneumothorax the expired volume of the still active lung sinks to about the half of that of both lungs, while through the opening in the thorax a much larger volume of air passes in and out. The aeration of the blood is very incomplete. When the thoracic opening is closed the respiratory volume rises above the normal again. When the trachea is compressed the respirations diminish in frequency, but increase in depth, while the respiratory volume does not become much altered. Venesection causes a diminution of the volume at first, but it speedily returns to the normal, if the bleeding has not been very great. If the loss of blood has been great the diminution of volume continues. Morphia diminishes the respiratory volume. So also section of the spinal cord, cooling of the animal, and varnishing the skin. Warmth causes increase of the volume. Goldstein (*Inauguralabhand., Würzburg*) writes on warmth-dyspnœa, having made experiments with reference to the observations of Ackermann, that the frequency of respiration becomes much increased when an animal is kept at a high temperature. Neither morphia nor chloroform narcosis affect this result. Section of the vagi is likewise without effect. Cold affusion is also without effect on the respirations. Goldstein attributes the action to the direct influence of heat on the respiratory centre. He shewed this by heating the blood as it passed up the carotids, and finding that the respirations were quickened even after section of both vagi. Cooling of the blood in the carotids had exactly a contrary effect, the frequency of the respirations being appreciably reduced.

CIRCULATION IN THE LUNG.—Quincke and Pfeiffer (*Reichert u. Dubois Reymond's Archiv*, 1871, 90—116) have investigated what influence the expansion and contraction of the lungs have on the flow of blood through them. On this subject there exist different opinions. Their experiments were made on the fresh lungs of dogs killed by bleeding. The defibrinated blood was forced through the lung under a constant pressure, and the amount that flowed out in a given time under different conditions of expansion and contraction of the lung compared. They found that when the lung was expanded by withdrawing the pressure from its surface (as in the thorax) the outflow of blood increased with the expansion. This condition, as shewn by manometric measurements, corresponded with increased area of the pulmonary vessels. When the lungs, on the other hand, were expanded by blowing air into them, the flow of blood through them was greatly diminished, and could be entirely stopped by increasing the expansion. This condition corresponded with contracted area of the vessels.

A REFLEX RELATION BETWEEN THE LUNGS AND HEART.—Hering (*Wien. Acad. Sitz.*, LXIV.) finds that inflation of the lungs has an influence on the frequency of the pulsation of the heart. His experiments were made on dogs by inserting a cannula into the trachea and inflating the lungs. He found that inflation caused a marked increase in the number of pulsations. He shews this is not due to pressure on the heart, nor to alterations in the blood-pressure, nor to variations in the gases of the blood. It is due to a reflex action in the heart through the vagi. After section of the vagi the inflation of the lungs has no such effect. As, however, section of the vagi of itself causes increase of the rapidity of the heart, it was necessary to bring the heart to a normal rapidity by irritation of the vagus before trying the effect of inflation. Hering concludes that the inflation causes excitation of sensory fibres in the lungs, which excitation depresses the inhibitory centres of the heart. That it is not due to reflex excitation of excito-motor nerves of the heart is shewn by the fact, that after section of the vagi or paralysis of the same by atropia inflation has no longer any influence on the already quickened heart.

Artificial Respiration.—Horvath (*Centralblatt*, No. 50, 1871) recommends a simple method of keeping up artificial respiration both in physiological experiments and in critical surgical cases. Instead of inserting a cannula into the trachea in the usual way, he found that the lungs could be inflated by simply placing an elastic tube over the nostrils and blowing into them with an ordinary spray-producing pump. The mouth remains more or less open and allows the excess of air which does not reach the lungs to escape, and thus acts as a sort of safety-valve against hyper-distention. The regular rise and fall of the abdomen shews that the lungs are inflated and respiration carried on by this means. Several experiments on curarised animals shewed its applicability and success.

Muscular Fibres of the Minute Bronchial Tubes and the Lung Parenchyma.—Rindfleisch (*Centralblatt*, No. 5, 1872) communicates a preliminary notice of his investigations on the musculature of the bronchia and lungs. The following are his conclusions. The smallest bronchial tubes possess a distinct layer of circular muscular fibres which at the point of passage into the infundibula become strengthened into a sphincter. They are very dilatable and possess under the epithelium a rich capillary network like the rest of the lung capillaries. The circular fibres send loop-like prolongations into the openings of the infundibula which reach as far as the fundus. Rings of muscular fibres also exist in from two to four points of the infundibula themselves. These rings lie generally in the inwardly projecting margins of the septa of the alveoli. All these muscular fibres undergo hyperplasia in the so-called brown induration of the lungs.

Muscular System.

Relation of Glycogen to Muscular Action.—Weiss (*Wien. Acad. Sitzber.* (2) LXIV. 284—291) shews that muscular action is associated with a marked diminution in the amount of glycogen of the muscle. In one set of experiments on frogs the percentage loss was 24·27; in another it was 28·24, and in another it was 50·427 where only the larger muscles were compared together. As regards the heart, which is in constant activity, it was found that notwithstanding its constant activity it had a store of glycogen amounting to more than two-thirds that of the other muscles.

The amount of glycogen in the muscle does not vary with the food to the same extent as the glycogen of the liver. This was shewn by experiments on fowls. Nor does it disappear so readily as the liver glycogen when the animal is starved. This fact would seem to account for the retention of muscular energy even in starvation.

Temperature.

LOSS OF TEMPERATURE.—Ackermann (*Berlin. Klin. Wochensch.*, 1872, Jan., p. 27) considers that the cooling of animals which occurs when they are fastened down to a board is not due to pain (compare this, *Journal*, Vol. v. p. 409), but to the surface of the abdomen being freely exposed to air and not kept warm by the legs or ground. The blood which circulates in the abdominal viscera in great quantity is thus quickly cooled through the thin abdominal walls. In support of this he cites the much greater feeling of cold which is felt when a person lies on his back in bed in a cold room thinly covered, than when he lies on his abdomen or on his side with his knees drawn up. There are three ways in which warmth is given off at one part of the body when it is retained at another.

1st. In the lungs. Increased temperature of the body causes increased respiration and more rapid evolution of heat.

2nd. In the skin. When one part of it is warmed, or cooled, there is a greater or less flow of blood in some other part of it more or less distant, so that while heat is taken in or abstracted at the former part, it is given off or retained at the latter.

3rd. By the action of carbonic acid on the vaso-motor system. When respiration is hindered and the usual amount of heat is not given off from the lungs, the carbonic acid which is caused to accumulate in the blood causes contraction of the vessels, raises the blood-pressure and increases the loss of heat from the surface.

ON THE PRODUCTION OF HEAT AND THE TISSUE METAMORPHOSIS IN THE NORMAL AND FEBRILE CONDITION.—Senator (*Centralblatt*, Nos. 47—48, 1871) thus states the results of his investigations on this subject:

1. In the ordinary tranquil condition in the waking state and when digestion is not going on, the production and giving off of heat vary only in comparatively narrow limits.
2. In prolonged fasting the production of heat and the excretion of carbonic acid gradually decrease.
3. During digestion (half-an-hour to three hours after eating) the evolution of carbonic acid and production of heat increase very markedly but not in equal proportion, for the increase of heat is greater than the increase of carbonic acid.
4. During cooling of the surface of the body, which causes great loss of heat, the heat production is not apparently increased, while the excretion of carbonic acid is distinctly so. The production of heat and the excretion of carbonic acid, therefore, do not entirely correspond, and still more remarkable is the fact, that in certain conditions the excretion of carbonic acid can increase without a corresponding increase in the heat production and without mechanical work.
5. In the commencement of fever induced by subcutaneous injection of pus, neither the loss of heat nor the excretion of carbonic acid is increased.

6. At the height of the fever (40°—41 C°) the giving off of carbonic acid and heat is sometimes slightly increased, often however not appreciably. The two processes do not correspond exactly.

7. The increased carbonic and excretion is always less than the increase of urea, which occurs without exception.

8. Notwithstanding the partial increase of tissue metamorphosis in fever, yet the amount of potential energy set free does not come up to that of a healthy well-nourished state of the body.

Digestion.

SEPARATION OF DIGESTIVE FERMENTS.—Paschutin (*Centralb.*, 1872, p. 97) finds that the ferments from the small intestine of the dog, which change starch and cane-sugar into grape-sugar, can be separated from one another by filtration, through porous cells, with the aid of a water air-pump.

The pancreatic ferments can also be separated from one another in a similar way. Instead of using watery extracts of the gland, it is better to use extracts made with concentrated solutions of various salts, some of which dissolve one ferment and some another. Thus the ferment which acts on albumen can be extracted almost pure by Rochelle salts, sodium hyposulphite, ammonium nitrate, &c., that which acts on starch by potash arsenite, and that which acts on fat by potash antimoniate, sodium bicarbonate, &c.

ABSORPTION AND ASSIMILATION OF ALBUMEN.—Stockvis (*Nederland Tydschrift voor Geneeskunde*, April, 1872) considers that there can no longer be any doubt that albumen is absorbed as such from the intestine and is not completely converted into peptones before absorption. This is shewn by the fact observed by him (*Ned. Tydsch.*, 1862, 398), as well as by others, that white of egg appears in the urine when introduced in large quantities into the stomach, and also when injected into the rectum. Only a small proportion of the albumen taken into the alimentary canal is absorbed as such, the greater part being converted into peptones; but this amount, although small, is probably sufficient to replace the waste of albumen in the organs, which is but slight. What becomes of the peptones is not certain, but he considers Fick's hypothesis very probable, that they are split up into hydrocarbous and nitrogenous substances, the former of which are stored up in the body for use, while the latter are quickly converted into urea and excreted.

NEW PROOF THAT ALBUMEN IS ABSORBED AS SUCH FROM THE INTESTINE.—Stockvis (*Maandblad des sectie voor Naturwetenschappen*, 1872, No. 6) finds that when the peculiar albumen discovered by Bence Jones in the urine of patients suffering from osteomalachie is injected into the rectum of dogs, it appears again in their urine. When egg albumen has been found in the urine after being injected in this way, doubts have been entertained as to the albumen found in the urine being really egg albumen, but the characters of Bence Jones's albumen are so peculiar as to prevent its being confounded with anything else. It is coagulated at 45—60° C, and the coagulum thus formed, as well as that produced by metallic salts, is dissolved when the temperature is raised to 96—100° C.

Miscellaneous.

UTERINE CONTRACTIONS.—Oser and Schlesinger (*Centralblatt*, No. 52, 1871) have investigated the relation of the movements of the uterus to the quantity and quality of the blood, both in the uterus itself and also in the central nervous system. Their experiments were made on 120 animals, dogs, cats, and rabbits. The animals found most suited for experimentation were youngish rabbits, which had reached nearly the full period of gestation, and whose uterus, on opening the abdomen, did not exhibit any spontaneous movements.

The following are the chief results arrived at:

Cessation of artificial respiration in curarised animals causes, in a period varying from ten to thirty seconds, a tetanic contraction, which commences first in the Fallopian tubes, and soon involves the whole organ. The uterus becomes pale, cylindrical and contracted. The horns become curved and overlap each other, and the uterus forms, at the height of contraction, a coiled-up ball in the middle line. When respiration is restored, the uterus becomes gradually relaxed, and returns to its original form as it regains its vascularity. Compression of the aorta in the thoracic region, or beneath the diaphragm, causes a similar though less intense contraction, but which does not ensue till after a period of from seventy to a hundred and twenty seconds. The contractions occur at the same time, when the vena cava is compressed along with the aorta. If spontaneous contractions are present, they speedily cease after compression. When the arterial supply returns, after the compression is relieved, there occurs sometimes a powerful general contraction, and then the uterus returns to a state of rest. If the aorta is compressed, and at the same time the respiration is caused to cease, there occurs a general uterine convulsion at the same period as when the respiration only is checked, viz. after 10—30 seconds. Anæmia induced by bleeding, causes, after 5—15 seconds, general tetanic contractions. If the aorta and vena cava are compressed together, and at the same time anæmia of the brain is caused by rapid opening of the carotids, then there occurs a general contraction at the same time as when the vessels are not compressed. Cutting off the arterial supply of the brain, by tying all the branches of the aorta which send blood to the brain, causes a general uterine contraction after 10—30 seconds. If only the innominate and the corresponding carotid are closed, while blood is allowed to flow to the brain through the subclavia sinistra, then no contractions ensue. After division of the medulla between the occiput and atlas, then the action of influence of suspension of the respiration does not manifest itself so soon as before the division. Sometimes it thus happens, that the time in which contractions occur when the aorta is compressed, is shorter than before the division of the medulla. After section of the medulla, acute anæmia produced by blood-letting has no effect, neither does cutting off the blood-supply of the brain produce any effect on the uterus after the medulla is so divided. Suspension of the respiration produces its effect, notwithstanding section of the vagi and the sympathetics. So also with anæmia and cutting off the blood-supply of the brain.

Hence irritation of the central nervous system by these means causes uterine contractions. The centre irritated is higher than the point cut, and the propagation of the stimulus is conveyed through the spinal cord. Asphyxiated blood in the uterus causes the same phenomena directly, but they occur later than the irritation proceeding from the central nervous system.

CAUSE OF MULTIPLE METASTATIC ABSCESSES.—Recklinghausen (*Centralblatt*, No. 45, 1871) believes that he has discovered the cause of the multiple metastatic abscesses, which occur in a whole series of infectious diseases, especially in pyæmia, puerperal fever, typhus, acute arthritis, and lastly infiltration of urine, and gangrene of the lung. He thinks these 'abscesses' are due to colonies of minute organisms, which have the characters of micrococcus, and which are identical with the organisms found by Buhl, Oertel, and Nassiloff in diphtheria. Recklinghausen found these colonies in greatest abundance in the kidneys, generally surrounded by a zone of extravasation, or purulent deposit. These were found not merely round the blood-vessels, but also within the Malpighian capsules, and the uriniferous tubules, and also in the bladder washed away from these parts by the urine. Sometimes the colonies were so thick that they caused a nodulated appearance of the tubule, and sometimes caused rupture. Organisms described as nodulated trabeculæ of a greenish tint were found in one case of scarlatina in the pyramids. These were quite different from the micrococci. These colonies cannot, as Recklinghausen thinks, be attributed to embolisms, as they occur in extravascular regions and also in the alveoli of the lungs.

HEREDITARY TRANSMISSION OF ACQUIRED QUALITIES.—Brown-Séquard and Dupuy (*Rev. Scientifique*, 1871-72, p. 668) have observed partial closure of the eyelids in a whole litter of a guinea-pig whose sympathetic had been cut in the neck.

INFLUENCE OF BAROMETRIC PRESSURE ON VITAL PHENOMENA.—P. Bert (*Comptes Rendus*, Feb. 26, 1872) continues his researches on this subject (see *Report* in *Journ.*, Nov. 1871). He seeks to determine what results follow when animals are placed in artificial atmospheres richer in oxygen than ordinary air. He finds that a sparrow dies in a hyperoxygenated atmosphere at the normal pressure, and temperature of 12—15°, when the atmosphere became charged with about 25 per cent of carbonic acid. This also holds for lower pressure down to 25 centimetres. Below this the proportion is not so constant, but differs the more, the less the pressure. Just as in ordinary air, so in hyperoxygenated air at low pressures, death ensues from deprivation of oxygen. The influence of carbonic acid or of oxygen on the animal economy is in direct relation with the elastic force which these gases present in closed receivers. This force depends on two factors, the percentage composition, and the manometric pressure. However the experiments be varied, a double result is obtained. (1) Sparrows are killed by carbonic acid, when the tension of this gas in the receiver is equivalent to ·25 of a gaseous mixture at the normal pressure, or in other words, to that of an atmosphere of pure carbonic acid at a pressure of 76 × 0·25 = 19 centimet. of mercury. (2) Sparrows perish by deprivation of oxygen, when the elastic tension of this gas is equivalent to ·035 of a gaseous mixture at the normal pressure, or in other words, to that of an atmosphere of pure oxygen, considered at a pressure of 76 × 0·035 = 2·66 centimet. of mercury.

The fact that a sparrow can remain alive, after remaining some time in air containing 87 per cent. of oxygen, at a pressure of 6 centimet. of mercury, shews that the death by diminution of pressure is not due to any general action of a physical or mechanical nature, but simply to a suppression of the respiratory function, or absorption of oxygen.

When, on the other hand, animals are placed in hyperoxygenated air above the normal pressure, remarkable results ensue.

When the pressure is raised to four or five atmospheres, the animal gives signs of uneasiness, and after about ten minutes becomes violently convulsed. Death ensues in about half-an-hour.

The convulsions are not due to the mere pressure, since sparrows can support without inconvenience a pressure of from eight to nine atmospheres. The effects are due to the toxic influence of excess of oxygen. This influence begins to be shewn at three atmospheres, but convulsions do not result till the pressure reaches about four. This would correspond with a pressure of fourteen atmospheres of ordinary air. It appears, therefore, that oxygen, when its proportion to the blood is notably augmented, acts as a poison, and causes death by convulsions. M. Bert continues his researches in the physiology of this interesting subject.

DR FRASER'S REPORT.

Physiological Action of Medicinal and Poisonous Substances.

CHLORIDES.—The researches of Dr Rabuteau into the chemical changes that accompany the action of various medicinal substances have been frequently referred to in previous reports. He has recently made some experiments with the chlorides of sodium, potassium, ammonium, magnesium, iron, gold and palladium (*Académie des Sciences*, and *Journal de Pharmacie et de Chemie*, Mars, 1872, p. 207), which have yielded results of considerable interest. The first three of these salts were found to have an important influence in increasing the activity of the nutritive processes; for they augment the elimination of urea, and elevate the temperature of the body. Chloride of potassium, however, differs from the chlorides of sodium and ammonium, in so far that it reduces the pulse-rate, while the two other chlorides accelerate it. Their action on nutrition may be explained by the increase in the quantity and acidity of the gastric juice, which Dr Rabuteau has observed to occur, and also by the augmentation in the number of the red corpuscles of the blood, which has been shown by Drs Plouviez and Poggiale to take place after the administration of alkaline chlorides. These effects explain why animals living upon a salt diet do not increase in weight, notwithstanding the large quantities of food they consume under the promptings of an increased appetite. The most important result that was obtained in the experiments with chloride of magnesium is that this salt possesses a valuable cathartic action—an action which, in common with that of other salines, depends on modifications of osmosis. Hence, the cathartic influence is produced only when a comparatively large dose (three or four drachms) is introduced into the intestinal canal. When a small dose is injected into the circulation, or introduced into the intestinal canal, the effect is the production of diuresis and constipation, and not of catharsis. Dr Rabuteau has established that perchloride of iron is reduced to a protosalt when brought into contact with albuminoid and other organic substances, and that this reduction occurs in the sysetm. He confirms Dr Blake's observation, that the protochloride diminishes the coagulability of the blood, and also that its toxic power is feeble; but he adds the important fact, that it is absorbed with great facility from the stomach. Further, he shows that reduced iron and the carbonate and oxides of that metal are transformed into protochloride by the hydrochloric acid of the gastric juice, and suggests, that in the treatment of disease the latter substance should be substituted for the former preparations. A similar reduction occurs when chloride of gold or of palladium is introduced into the system; and albuminuria, dependent on renal lesions, follows their prolonged administration.

Bromides.—In studying the physiological effects of the bromides, Dr Bartholow, of Cincinnati, adopted the plan of first determining the nature of their action in man, and then of investigating the *modus operandi* of their action by experiments on the lower animals. The results of his study have been published in an essay (*Bromides: their physiological effects and therapeutical uses*, 1871), for which the author has had the good fortune to obtain the "Fisk Fund Prize." The conclusions arrived at regarding the physiological action of bromides are interesting, although in some particulars opposed to those of other observers. He believes that the bromides of potassium, ammonium, and sodium generally correspond in the symptoms they produce and in their mode of action. They all produce weakness, trembling, and defective coördination of muscular movements, and, finally, complete paralysis, which Dr Bartholow refers to destruction of the irritability of muscles and the sensibility of motor nerves; but these effects are more powerfully produced by bromide of potassium and ammonium than by bromide of sodium. They depress the action of the heart, and lower the animal temperature; but the bromide of sodium is the most, and the bromide of ammonium is the least, powerful in this respect. Each of them diminishes the functions of the brain, producing somnolence; but this effect is more readily induced by bromide of sodium than by bromide of potassium, and by the latter more than by bromide of ammonium. Finally, as toxic agents, bromide of potassium takes the first place, bromide of ammonium the second, and bromide of sodium the third.

ALCOHOL.—Dr Dupré has made some very interesting experiments, which throw much light on the changes that take place in alcohol after its absorption into the blood (*Proc. R. S. London*, and *Practitioner*, March, 1872, p. 148). Previously to 1860, it was generally supposed that the greater portion of the alcohol taken was oxidised in the system, and only a small portion eliminated unchanged. The well-known experiments of Perrin and Lallemand, published in that year, led however, to the adoption of the opinion that all, or at least nearly all, the alcohol taken is eliminated unchanged. This opinion was opposed by Dr Anstie and others, but supported by the careful experiments of Drs Parkes and Wollowicz. In order to determine which of these conflicting views is correct, Dr Dupré was induced to investigate the subject. He assumes, for the sake of argument, that all the alcohol is eliminated, and that such elimination takes ten days (the maximum period that can reasonably be allowed); from which it must follow that if a certain quantity be taken daily, the amount eliminated will increase from day to day until, from the tenth day onwards, the amount daily eliminated would equal the amount daily consumed. If this theory were correct, therefore, the quantities that were eliminated would be large, and the most ordinary processes of analysis could not fail to yield considerable quantities of alcohol. The results of Dr Dupré's experiments, however, did not lend any support to this theory of alcohol elimination; for they showed:—1st, That the amount of alcohol eliminated daily does not increase with the continuance of the alcohol diet; and, therefore, that all the alcohol consumed daily must of necessity be disposed of daily. As the experiments proved that it is not eliminated within that time, it follows that it must be destroyed in the system. 2ndly, That the elimination following the taking of a dose or doses of alcohol is completed twenty-four hours after the last dose of alcohol has been taken. 3rdly, That the amount of alcohol eliminated in both breath and urine is only a minute fraction of the amount of alcohol taken. In the experiments from which the above conclusions were arrived at, Dr Dupré discovered that, even after ten days of total abstinence, the urine, when treated as for the estimation of alcohol, yielded some volatile acid having the general properties of acetic acid; and that a similar substance was present in the urine of a teetotaller. Some further experiments (*Practitioner*, April, 1872, p. 224) have led him to conclude that this substance is a normal constituent of human urine, or at least may be obtained from it by distillation with an acid. The presence of this substance introduces an important cause of fallacy in the application of tests for detecting the presence of alcohol, as with many of these tests it yields the same reactions as alcohol.

CHLOROFORM. In his very interesting lectures delivered before the College of France on anæsthetics, Claude Bernard advanced the theory that chloroform is able to produce general insensibility by the transmission of a nervous influence from the cerebral centre to the spinal centre, and from thence to the periphery; but that this influence could not travel in an inverse direction. This theory was founded on experiments on frogs, in which, after the circulation was abolished by removal of the heart, and after a ligature had been tied round the trunk at the axilla, the application of chloroform to the anterior part produced anæsthesia, not in that part only, but also in the posterior part, or below the ligature. This result was not obtained, however, when the spinal cord was divided; and thus the theory was supported that the anæsthesia of the part below the ligature was due to the transmission of an influence through the nervous system. Imagining that these results might be explained by the inhibition and filtering of the chloroform through the tissues, Dr J. L. Prevost, of Geneva, undertook some experiments for the purpose of definitely settling the truth of his supposition (*Practitioner*, July, 1871, p. 1). He found that chloroform always produced anæsthesia in the parts of the nervous system with which it was brought into contact; but that when the possibility of inhibition or passage by filtration was guarded against, no anæsthetising influence was exerted by a chloroformised brain upon the spinal cord or nerves. He, therefore, believes that chloroform anæsthetises only those parts with which it is in actual contact. The theory suggested by Bernard's experiments of an action by chloroform upon inhibitory cells in the brain, whose stimulation suspends the sensibility of the spinal cord, would, therefore, appear to be an unnecessary one.—Dr A. H. Smith suggests that one of the causes of death by chloroform is anæsthesia of the lungs (*The American Journal of the Medical Sciences*, 1871, p. 580). He believes that this cause operates by rendering the lungs insensible to the presence of carbonic acid, and thus removing the stimulus to respiration.

CHLORAL HYDRATE. Among the many researches that have originated from Liebreich's important discovery of the hypnotic action of chloral hydrate, one of the most interesting is that published by MM. Byasson and Follet (*Journal de l'Anatomie*, 1870—71, p. 570) on the relations between the physiological action of chloral hydrate and that of trichloracetate of soda. It is well known that the former substance is decomposed by the alkaline hydrates, and also by salts of the alkalies, into chloroform and a formiate. The latter substance undergoes a similar transformation in presence of alkaline hydrates, but the products of its transformation are chiefly chloroform and alkaline carbonates. From a large number of experiments in which the action of these substances and of chloroform were compared together, the author found that each of them produces certain phenomena which indicate differences in their mode of action. In whatever way chloral hydrate is administered, the intensity and duration of its action, and the modification of sensibility it produces, are not the same as those resulting from the administration of chloroform. The train of symptoms produced by trichloracetate of soda much more closely resembles that produced by chloroform than by chloral hydrate. Of the three substances, chloroform, when exhibited by inhalation, exerts the most powerful anæsthetic action; and its action is not only rapid, but it is also of comparatively brief duration. When, however, it is introduced by subcutaneous injection its anæsthetic power is less feeble than that either of chloral or of trichloracetates. Chloral hydrate, admininistered by the stomach or by subcutaneous injection, has a more powerful hypnotic action than the two other substances, but a less powerful anæsthetic action than chloroform. Its action is rapid, and of long duration. Trichloracetate of soda, however introduced, produces very much the same action as chloroform when it is slowly introduced into the blood. As a result of their researches, the authors believe that they have obtained satisfactory evidence in confirmation of Liebreich's theory of the decomposition of chloral in the body, but that this evidence proves, in opposition to Liebreich, that the action of chloral does not alone depend on the chloroform produced by this decomposition. The formic acid, simultaneously produced, is an important factor in the action of chloral. This substance is converted by the blood into carbonic acid, and in its conversion a portion of the oxygen of the blood is absorbed. Hence the blood assumes a venous hue during the action of chloral, and the symptoms and post-mortem appearances resulting from a poisonous dose of this substance are those of asphyxia. In reference to the effects of chloral itself, the authors distinguish three degrees of action, attained gradually and successively by increasing doses. In the first, there is feeble soporific action and slight sedation of the sensory nervous system, often accompanied with intermitting nervous agitation, similar to that caused by disturbed dreams. In the second, there is powerful soporific action, with decided diminution of sensibility; and calm sleep of varying duration occurs, without any apparent disturbance of the principal vital functions. By successive doses, administered when the action of each previous one is passing away, the hypnotic action may be safely continued for a long time. In the third degree of action there is decided anæsthesia, with complete loss of general sensibility, and perfect muscular flaccidity. Death is nearly always a result of the production of this degree of action; but it may often be obviated by artificial respiration or by the inhalation of oxygen. Complete anæsthesia, therefore, cannot be produced unless a toxic dose be administered.

CROTON-CHLORAL. The discoverer of the action of chloral has lately proposed another new remedy in croton-chloral (*Medical Times and Gazette*, Vol. II. 1871, p. 572), a substance obtained by acting upon allylene with chlorine. When given to animals in small doses, croton-chloral abolishes the sensibility of the head, that of the rest of the body being unimpaired; when given in larger doses, it paralyzes the spinal cord, the respiration and circulation remaining in a normal state; and, finally, and with toxic doses, it induces general paralysis and death by asphyxia. In some clinical observations, Liebreich established the remarkable fact that complete paralysis of the fifth pair of nerves may be produced by this substance, while the reflex excitability of all other parts of the body is unaffected. By means of this substance, therefore, the sensibility of the head may be completely abolished without any impairment of the sensibility of other parts. Should these observations be confiremd, practical medicine will be indebted to Liebreich for a most valuable remedy in the treatment of neuralgic affections of the face.

NITRITE OF AMYL. A memoir of great value has been published by Dr Horatio C. Wood, Jun., on the physiological action of nitrite of amyl (*American Journal of the Medical Sciences*, July, 1871, p. 39, and pamphlet), in which, while the previous observations of Brunton and others are confirmed, important additions are made to our knowledge. After a study of the general symptoms produced by this substance, Dr Wood examines in detail, by means of carefully devised experiments, its action on the nervous, muscular and circulatory systems, its local action on tissues, and its influence on temperature and on the respiratory changes of the blood. His experiments appear to show that nitrite of amyl is a powerful depressant of the general motor function, affecting to some extent muscular contractility, to a greater extent the conductivity of motor nerves, and still more profoundly the central motor ganglia in the cord. The activity of the sensory ganglia is likewise diminished, but not so rapidly nor completely as that of the motor ganglia; and, accordingly, sensation is never abolished until death is about to occur. Nitrite of amyl, therefore, is not properly an anæsthetic. In reference to its action on the circulation, Dr Wood agrees with Brunton in supposing that blood-pressure is decidely reduced, and chiefly by dilatation of the blood-vessels; but he further supposes that this result is also due to a direct paralysing action exerted on the muscular structure of the heart. The experiments in which nitrite of amyl was applied to the tissues, lead him to conclude that the functional activity of nerves and muscles is gradually diminished and then destroyed, that these effects are never preceded by increased excitability, while pain and redness, or other signs of local irritation, are never exhibited. It was found that a very decided effect was produced on the animal temperature by the constitutional action of this substance: for when small toxic doses were given, the temperature fell in a very remarkable manner; and when non-toxic doses were given, a considerable diminution occurred, but the lowest point in the fall was not reached until after the general symptoms had commenced to subside, while the subsequent rise to the normal temperature was very slowly effected. By a number of ingenious experiments Dr Wood shows that nitrite of amyl has the power of checking oxidation, or in other words, the chemical changes necessary to functional activity, by a primary action upon hæmoglobin. By virtue of this action, in all probability, the marked diminution of temperature is produced; for, coincidently with this diminution, there is a decided decrease in the amount of carbonic acid exhaled. An important action of nitrite of amyl, therefore, is that of impeding or arresting tissue metamorphoses—an action which appears to belong to nitrites generally, and which, as Dr Gamgee has shown, undoubtedly depends on the chemical changes produced in the blood by these compounds.

Carbolic Acid.—In a communication to the *Arch. Gén. de Méd.* (October, 1871), bearing chiefly on the therapeutical applications of carbolic acid, Dr Ernest Labbée states that, when given internally, this substance lowers the temperature of the body. In some experiments on frogs he proved that it causes convulsions of an epileptiform, rather than of a tetanic nature, which are due to an action upon the medulla oblongata.

Hydrocyanic Acid.—Dr Amory describes some experiments illustrative of the physiological and pathological action of hydrocyanic acid (*Practitioner*, April, 1872, p. 197). He thinks that asphyxia is not the cause of death by this substance, but he somewhat vaguely assigns this result to "some alteration either of the physical or the chemical condition of the blood." He examines with some detail the influence of artificial respiration upon the toxic action of this poison; and expresses the opinion that it prevents the occurrence of convulsions, but does not materially assist in the elimination of the poison.

Aconitia.—A crystalline alkaloid has been extracted by M. Duquesnel from Aconitum Napellus, which appears to be the true active principle of that plant (*Comptes Rendus de l'Acad. des Sciences*, 17 Juillet, 1871). In a note communicated to the French Academy, the results are mentioned of some experiments made with this alkaloid by MM. Gréhant and Duquesnel. When given to frogs in very minute doses (0·0007 grain), it quickly causes general flaccidity, which is induced by paralysis of the terminations of the motor nerves; the brain, spinal cord, sensory nerves, and heart being but little affected by the dose mentioned. When, however, a larger dose is given to frogs, a dose, for instance of 0·015 grain, the heart's contractions are arrested in a few minutes, and in consequence of the circulation of the poisoned blood being thus early stopped, the motor nerves retain their function for a long time. Similar results were obtained in warm-blooded animals; but in them it was necessary to prolong life by artificial respiration before the motor nerves could be completely paralysed.

Codeia Derivatives.—Dr Michael Foster has investigated the physiological properties of some of the derivatives of codeia, discovered by Dr Wright (*Medical Press and Circular*, Vol. II. 1871, p. 210). He finds that hydrochlorate of chlorotetracodeia and hydrobromate of bromotetramorphia, when given subcutaneously to adult cats, in doses of about one grain and a half, produced general excitement, almost amounting to delirium, along with great flow of saliva and dilatation of the pupils. In two experiments he found that these salts paralysed the cardiac inhibitory fibres of the vagus. When salts of deoxycodeia and deoxymorphia were given to cats, in similar doses, convulsions of an epileptic character were almost immediately produced; but they soon passed away, and then symptoms were produced of a kind very analogous to those following the administration of salts of tetracodeia and tetramorphia.

EUCALYPTUS GLOBULUS.—Very recently considerable attention has been directed to the therapeutic value of various preparations of Eucolyptus Globulus, a tree of gigantic size found in Australia and Tasmania. In a valuable memoir (*L'Eucalyptus Globulus; son importance en Agriculture, en Hygiène, et en Médecine*, 1870), Dr Gimbert describes some experiments bearing on the physiological action of this substance. When the essence, or Eucalyptol, is administered in large doses, the chief symptoms are slowing of the respirations, general feebleness, lowering of temperature, often feeble excited movements, and flaccidity. The flaccidity is not accompanied with a sufficient diminution in the heart's rate to account for its occurrence; and, indeed, in frogs perfect paralysis may be present while the heart's action is being continued at a rate not greatly below the normal. Dr Gimbert's experiments show that this flaccid state is not caused by paralysis of the brain, or sensory or motor nerves, but by suspension of the reflex function of the cord. The toxic effect and the various poisonous symptoms produced by Eucalyptus may be referred to this action.

CONIA.—From a very elaborate physiological and therapeutical research on conium and its active principle (*Mém. de la Société de Thérapeutique*, Tome III., 1871), MM. Damourette and Pelvet have been led to explain many of the complicated symptoms of conia by the double action of stimulation of the spinal cord and paralysis of the motor nerves, which it exerts. With small doses, the paralytic action is chiefly or only manifested; but with large doses, the spinal-stimulant action is rendered apparent by the tetanic spasms and convulsions that occur. The increased excitability of the cord, however, is obvious only during the first stage of conia action; for soon the terminations of the motor nerves become paralysed, and the excitant action is thereby masked. By this double action, likewise, the effects on the pupils, on the respiratory movements, and on the cardiac contractions may be explained. The increased excitability of the cord contracts the pupils, so long as the peripheral terminations of the oculo-motor nerve are yet unparalysed; it accelerates the respiratory movements while the motor nerves of respiration retain their function; and it causes palpitation without increasing the rate of the cardiac contractions, by exciting the cardiac fibres of the sympathetic, and by similarly affecting the cardiac inhibitory fibres of the vagi. When, at a later stage, the motor nerves have become paralysed, the pupils dilate, because the sphincter of the pupil is no longer able to oppose the dilating muscle; the respirations diminish in frequency and strength, and finally cease, in proportion to the completeness of the paralysis of the motor nerves of respiration; and the cardiac contractions become accelerated, owing to the removal of the inhibitory influence of the vagus. The slowing and stoppage of the heart's action that finally occur are explained by the ganglionic nerves of the heart and the muscular fibres of that organ being themselves affected at a late stage in the action. The authors lay considerable stress on the fact that conia modifies, in a marked manner, the physical properties of the blood, so that this fluid becomes dark in colour and non-coagulable; and they believe that the power of producing this effect confers decided *alterative* properties on conia. Hence this substance is said to be a valuable remedy in scrofula, syphilis, chronic rheumatism, skin affections, &c. In its local action, conia produces on nerves and muscles, in the first place, a briefly continuing irritant action, and then sedation, the latter being manifested by anæsthesia and loss of contractility. It has, besides, a well-marked influence in completely disorganizing the anatomical elements of the tissues with which it comes into contact. In reference to the double action of excitation and sedation produced by ordinary conia, it is important to bear in mind that this substance in reality consists of a variable mixture of two bases, viz. normal conia and methyl-conia. Experiments made by Dr Crum Brown and the Reporter, have rendered it probable that the former base exerts a purely motor-nerve-paralysing action, and that the spinal action of ordinary conia is due to the methyl-conia contained in it. The difficulty of obtaining conia free from methyl-conia prevented our submitting this supposition to any certain test; but there is now a prospect of such a test being applied, as Schiff has shown that normal conia may be obtained synthetically by a process which does not admit of any admixture with methyl-conia. A double action, similar to that above described, is also produced by atropia (see Vol. III. 1869, p. 357 of this *Journal*).—In a research on conia by Dr Verigo (*Centralblatt*, No. 2, 1871, p. 28), the power of this substance to produce convulsions and paralysis is confirmed, and the non-dependence of the former effect on changes of respiration is pointed out.

QUINIA.—Various facts have been known which suggested that quinia is able to excite uterine contractions, but the subject has only recently been investigated in a satisfactory manner. This investigation has been made by Dr Angelo Monteverdi (*La Nuava Liguria Medica*, and *New Remedies*, October, 1871, p. 91). According to this observer, quinia exerts a special action upon the grand sympathetic nervous system, whereby it causes contraction of the muscular fibres of the uterus, urinary bladder, intestinal canal and blood-vessels. The action on the uterus is specially marked in pregnant women; and therefore quinia must be given to them with caution, otherwise abortion may be produced. It may, however, be utilised with advantage in order to stimulate the uterine contractions; and as an ecbolic quinia seems to possess the following advantages over ergot:—it is less apt to injure the mother or fœtus, it is more certain in its action, it produces labour-pains of a character more closely resembling normal pains, and it may be administered at any stage of the labour. In virtue of its action on the uterus, quinia is also serviceable in cases of retention of the placenta, in the hæmorrhages of pregnancy, in amenorrhœa due to torpid conditions of the uterus, and in puerperal fever, hysteria, and hysteralgia. It augments the force and frequency of the heart's contractions when small doses are administered, and it depresses the circulation when the doses are large. Dr Monteverdi agrees with Professor Gubler in maintaining that morphia exerts an action in many respects antagonistic to that of quinia, and that the one substance may, therefore, be usefully employed in the treatment of poisoning by the other.

IPECACUANHA AND EMETIA.—From the results of his further experiments with ipecacuanha and emetia (see Vol. IV. 1870, p. 168 of this *Journal*), Dr Dyce Duckworth is able to confirm his previous statement that an engorged state of the lungs is present after poisoning by these substances (*St Bartholomew's Hospital Report*, Vol. VII. and pamphlet). He believes that in toxic doses they exert a very decided paralysing action on the heart, that they lower the temperature, and render the urine albuminous. He is led to conclude from some carefully performed experiments, that emetia exerts no important influence upon arterial tension; but, unfortunately, the experiments from which this conclusion is deduced were not altogether satisfactory, for the characteristic emetic action of ipecacuanha was not produced in them, notwithstanding that large, and even fatal, doses were given. By the result of some experiments in which ipecacuanha and emetia were applied to the conjunctiva, prepuce, and skin, Duckworth confirms the statement of previous observers, that ipecacuanha is capable of producing local irritation.

DIGITALIS AND DIGITALIN.—Dr Gourvat finds (*Journal de Pharmacie et de Chimie*, Novembre, 1871, p. 386) that frogs are scarcely affected by doses of 0·001 grain of digitalin; but that a short period of excitation followed by general feebleness, lasting for several hours, is produced by doses ranging from 0·004 to 0·007 grain. Doses of from 0·015 to 0·05 grain, however, may speedily arrest the heart's contractions. He describes some experiments which show that digitalis rapidly suspends the contractility of striped muscle, and that it produces convulsive movements of the non-striped muscles. The latter action is well exhibited in the uterus, bladder and intestines. Dr Gourvat has carefully examined the action on the heart of dogs, rabbits, and frogs; and he thus summarizes his observations:—1. Under the influence of small doses, the beats of the heart are invariably slowed. 2. With large doses, acceleration precedes slowing. 3. Movements of the body, fatigue and pain, or other excitations, cause great variations in the results; and the presence of such causes of variation may explain the diversity of statement regarding the action of this substance on the heart. 4. Large doses augment the force of the heart's contractions, but they likewise produce irregular and tumultuous action.—Judging from the characters of the pulse-tracings after the administration of moderate doses to man, Dr Balthazar Foster (*Brit. and For. Med. Ch. Rev.*, Vol. XLVIII. 1871, p. 214) believes that digitalis causes a diminution in the frequency of the heart's beats, an increase in the force of each beat, and an increase in the arterial tension.—Dr Fothergill's elaborate inquiry on *Digitalis, its mode of action, and its use* (Hastings Prize Essay for 1870), leads him to entertain similar views regarding the action of digitalis on the heart. He observed that firm contraction of the ventricle, resulting in arrestment of the flow of blood, was produced by toxic doses in fishes, birds, and frogs; and in explanation of this result, he adopts the theory of Dybkowsky, Pellikan and others, that digitalis acts by stimulating the cardiac ganglia. He refers the diuretic action of digitalis to the increased blood-tension resulting from the augmented force of the cardiac contractions, and the constriction of the blood-vessels, which it causes.—The influence of digitalis upon the reflex inhibitory centres of frogs has been studied by Dr Weil (*Reichert und Du Bois Reymond's Archiv*, 1871). He finds that the infusion and active principle have a marked influence in lowering reflex excitability; in all probability, by exciting Setschenow's centre in the optic lobes.—Ackermann advances the opinion (*Berliner Klinische Wochenschrift*, 1872, p. 27) that digitalis acts beneficially in dropsies, by exciting the vaso-motor nerves, whereby the blood-pressure in the arteries is increased, while that in the veins is diminished, and the circulation accelerated. It results from these conditions that absorption of effused fluids is promoted, and their discharge from the system is speedily accomplished by the diuresis caused by the augmented blood-pressure.

ALOIN. From thirty-two experiments performed on pigeons, rabbits, cats, dogs and men, Dr McKendrick (*Edinburgh Medical Journal*, June, 1871, p. 1132) has arrived at the results:—1. That aloin is a purgative. 2. That it not only alters the characters of the fæces, rendering them softer and more mucous, but increases their quantity. 3. That aloin has little or no effect on pigeons or rabbits, except in doses of 3 or 4 grains. 4. That cats are powerfully affected by doses of from 1 to 3 grains. 5. That dogs are only slightly purged by doses of from ½ grain to 3 grains. 6. That aloin acts as a purgative in man in doses of from ½ to 3 grains.

ALCOHOL, TEA, COFFEE, COCA, MATÉ, &c. An elaborate examination of the effects produced by the chief paratriptic substances used as aliments, has led Dr Angel Marvaud (*Effets Physiologiques et Thérapeutiques des Aliments d'Epargne ou Antidéperditeurs*, Paris, 1871) to conclude that they exert a general stimulant action upon the cerebro-spinal nervous system, a retarding influence upon the processes of disintegration, and a lowering influence upon the temperature of the body. He believes that alcohol acts directly upon the sensitive apparatus of the cord, and indirectly upon the motor apparatus; that coca acts directly on the motor apparatus, which it excites in a manner similar to strychnia; and that coffee, tea, and maté act chiefly upon the brain. Alcohol and coca should, therefore, be regarded as drinks that specially excite muscular activity, while coffee, tea, and maté promote intellectual labour. They all act as anti-destructives, by hindering waste of tissue, retarding oxidation, and lessening the products of secretion. An explanation may thus be obtained of their power to excite to work, and to produce wakefulness, to supplement other aliments, and to moderate vital combustion. Two main inconveniences may be produced by their excessive use:—1, Inordinate excitement of the nervous system, resulting in fatigue, feebleness, and even inertia of that system; and 2, Excessive retardation of the processes of disintegration and combustion, resulting in arrestment or complete suppression of the nutritive functions, with resulting torpor, atony, fatty degeneration, and death of the tissue elements. Thus the production of alcoholism, caféism, thëism, and cocäism may be accounted for.

HEART-POISONS.—Dr Schmiedeberg shows (*Arbeiten aus der Physiologischen Anstalt zu Leipzig*, 1870) that nicotia paralyses the heart in diastole, and that this action may be prevented by minute doses of atropia. He is led to infer, from the behaviour of various cardiac poisons, that the vagus in frogs contains fibres whose excitation accelerates the heart, in addition to the inhibitory fibres.

COBRA-POISON.—From numerous experiments, Dr Shortt (*American Journal of the Med. Sciences*, July, 1871, p. 288; from *Madras Monthly Journal of Medical Science*) proves that comparatively large doses of cobra-poison produce death in a few minutes, while small doses do so only after many hours. So active is this poison, that five-sixths of a grain killed a large horse in 25 minutes, and one-twelfth of a grain killed a full-grown dog, weighing 18 pounds, in the same time. His experiments on the treatment of cobra-poisoning by ammonia have shown that this substance is worthless as an antidote.

SCORPION-VENOM.—M. Jousset (*Journal de Pharmacie et de Chimie*, Août, 1871, p. 148), has made some experiments from which he concludes that:—1, The venom of *scorpio occitanus* acts directly upon the red corpuscles of the blood, and, apparently, on them alone. 2, The action results in a destruction of the normal property of these globules to glide over each other. 3, By the loss of this property the red globules become agglutinated together so as to form little masses, which plug the capillaries and stop the circulation. Jousset adds that a certain minimum dose must always be given in order to produce death, for the venom does not act as a ferment.

Poisonous Mussels.—The occasional poisonous properties of the edible mussel (*Mytilus edulis*) are referred by M. de Beunie to their feeding on the spawn of star fishes (*Journal de Pharmacie et de Chimie*, October, 1871, p. 298). This spawn is shed in the months of April, May, July, and August; and it is chiefly in these months that injurious effects follow the eating of mussels. The spawn of the star-fish has an extremely irritant action, for the slightest contact with it causes insupportable itching, and may even occasion inflammation, terminating in gangrene.

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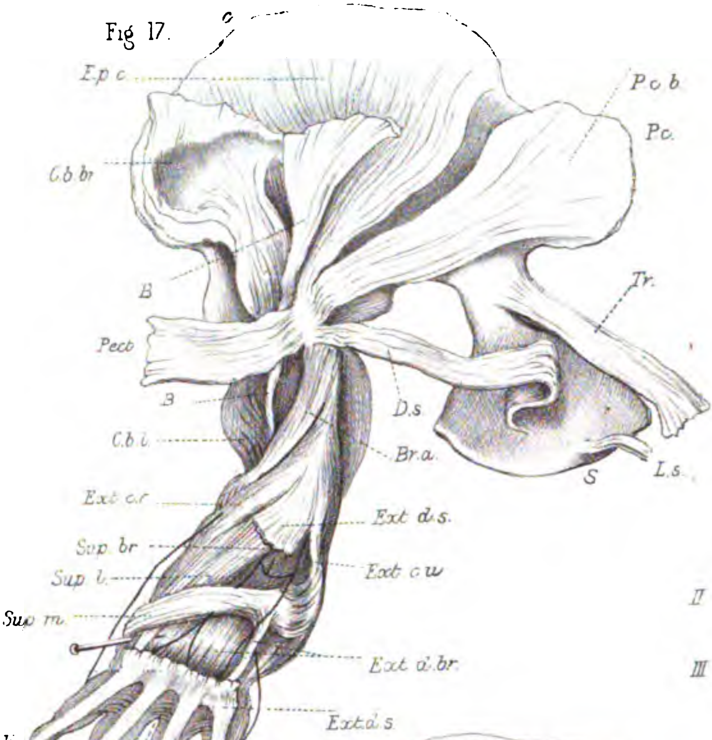
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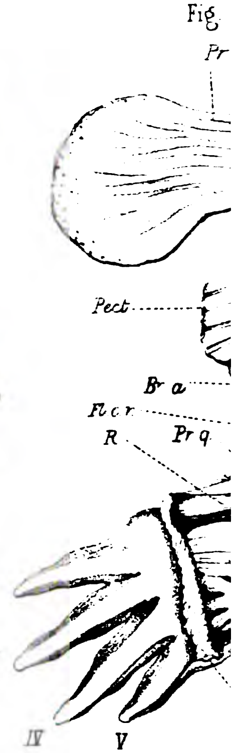
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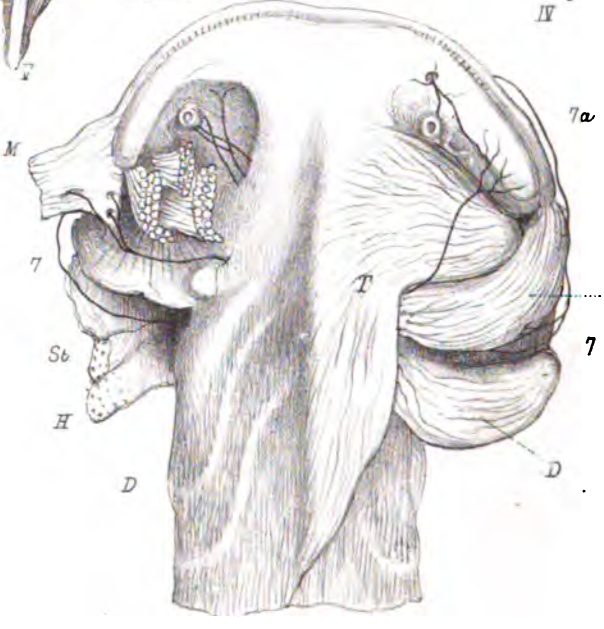
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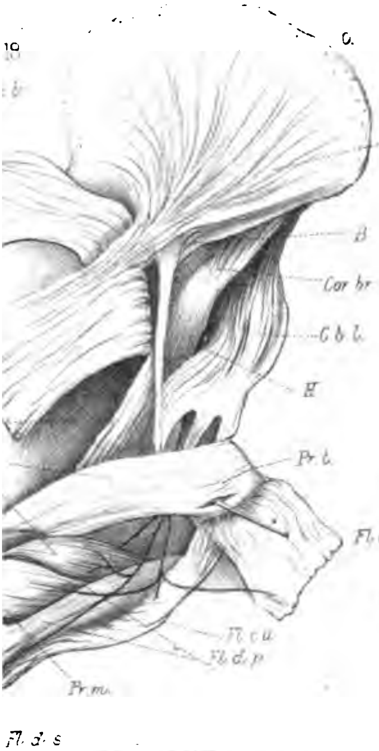
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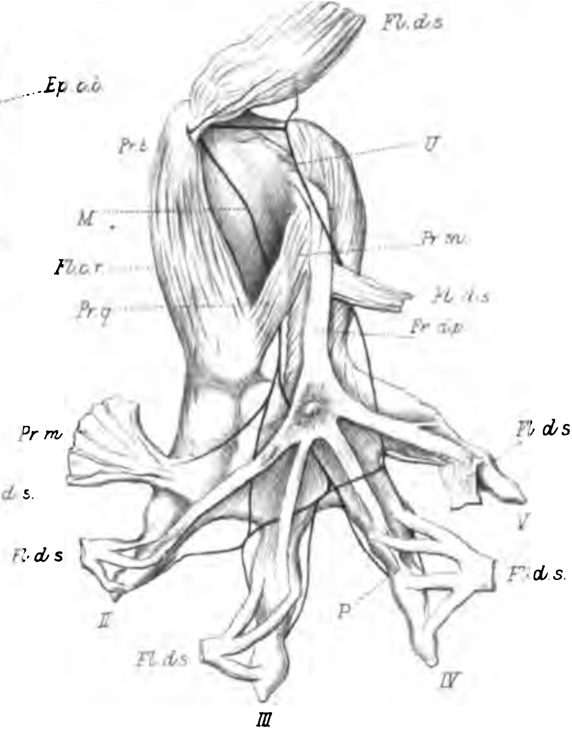
Fig. 19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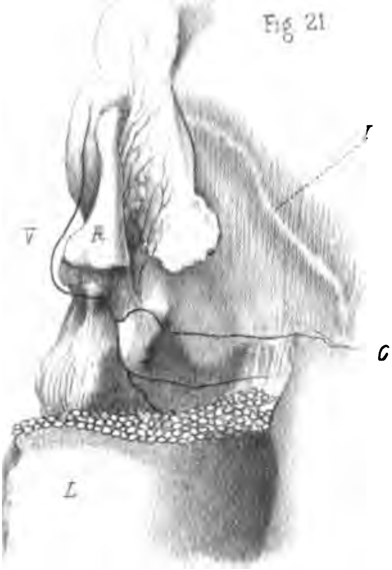

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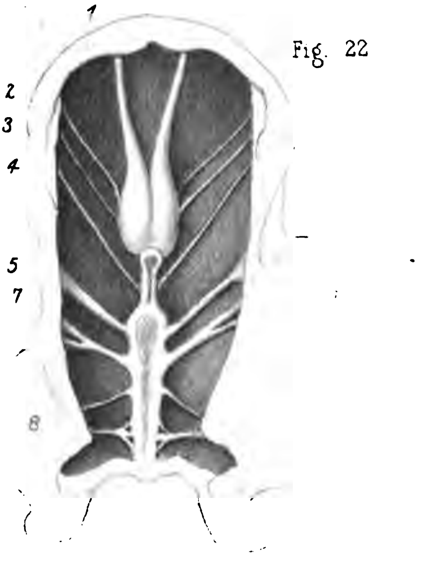

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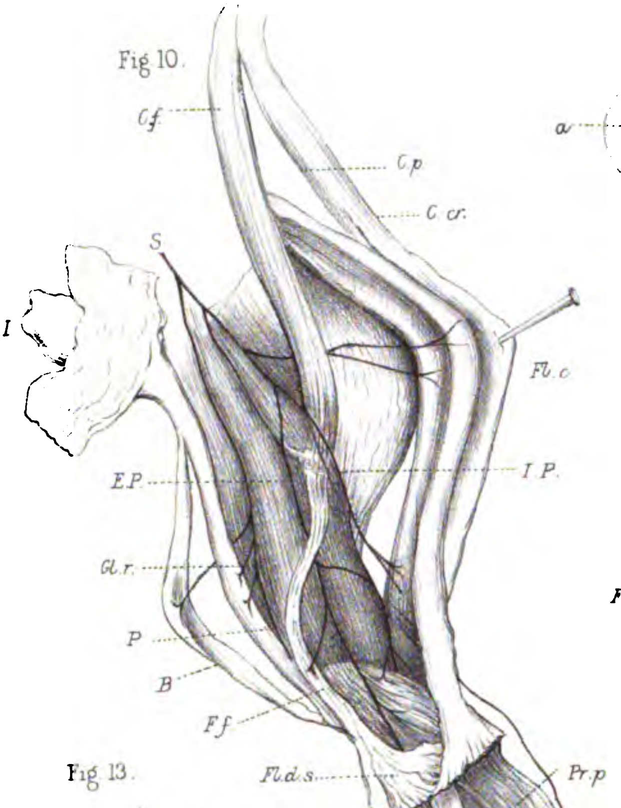
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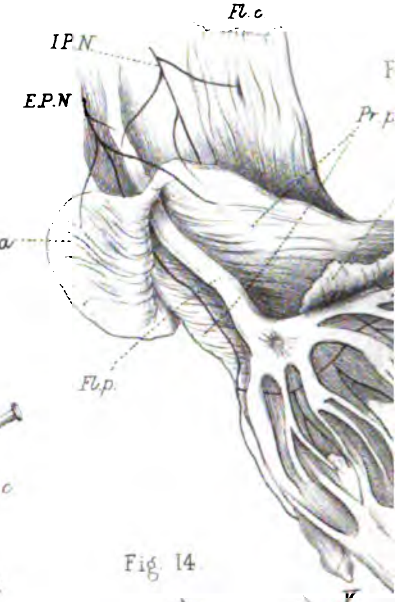
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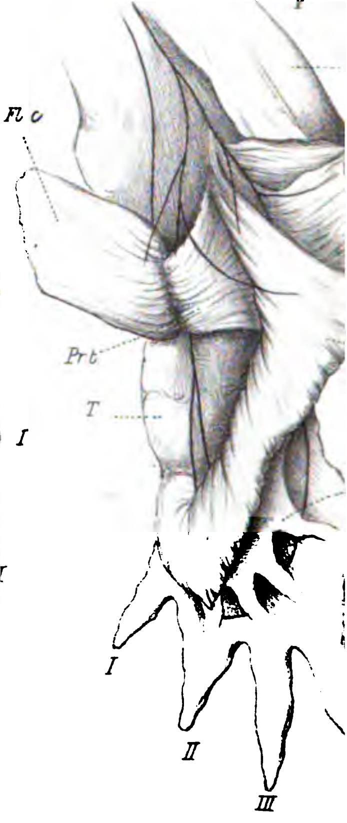
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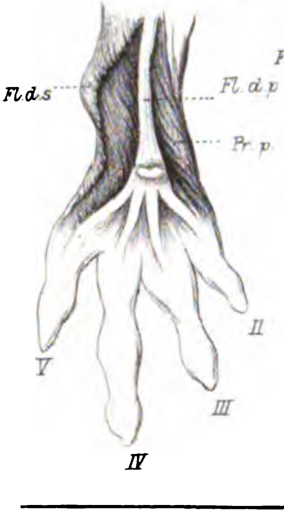
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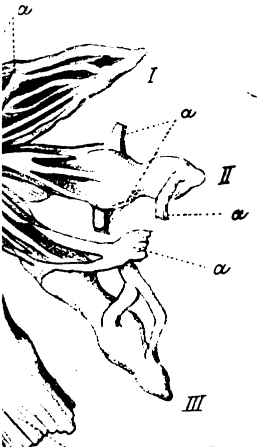
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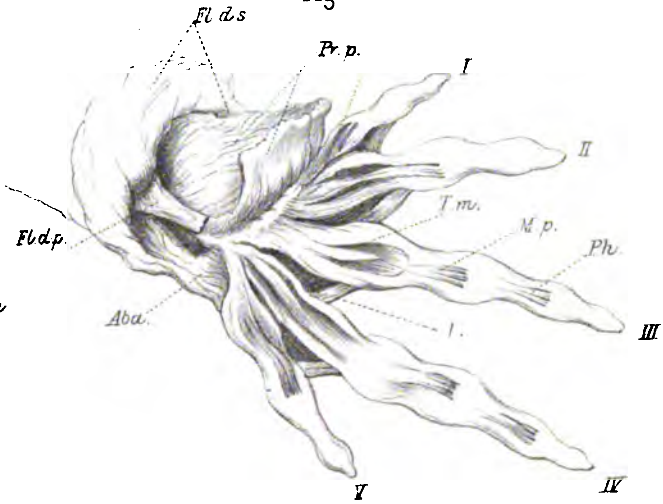
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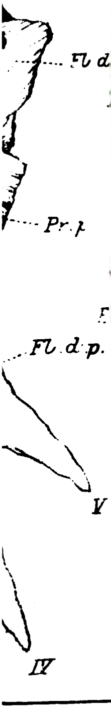
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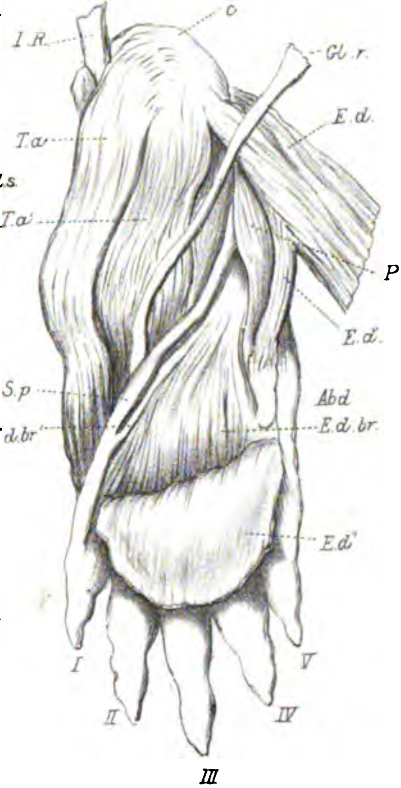
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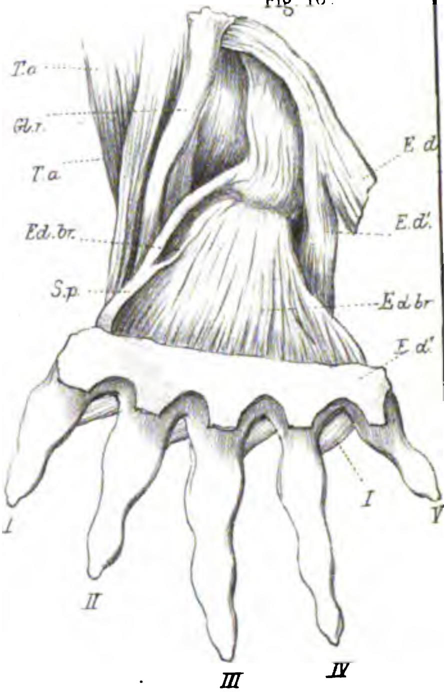
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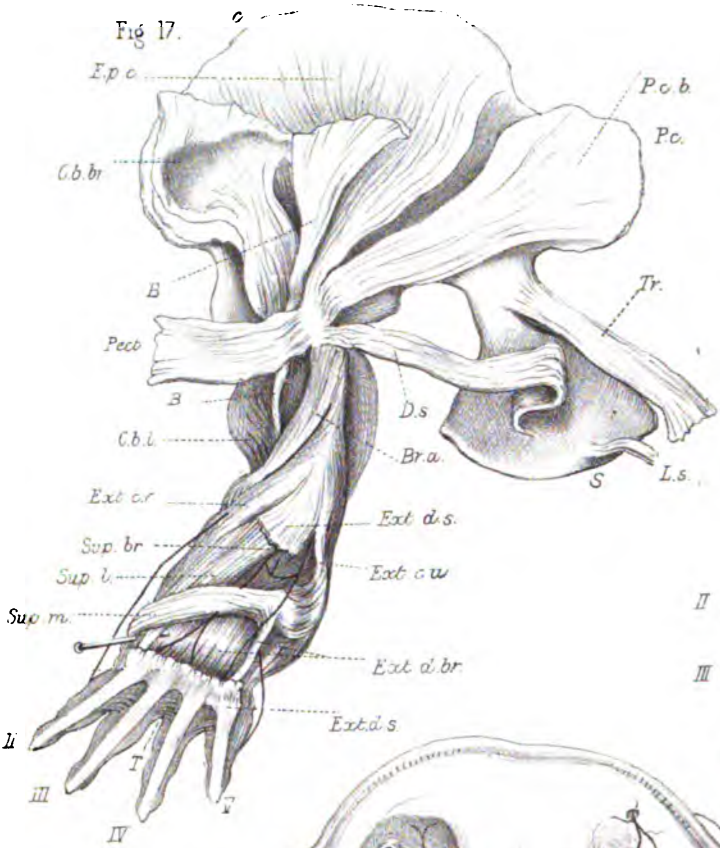
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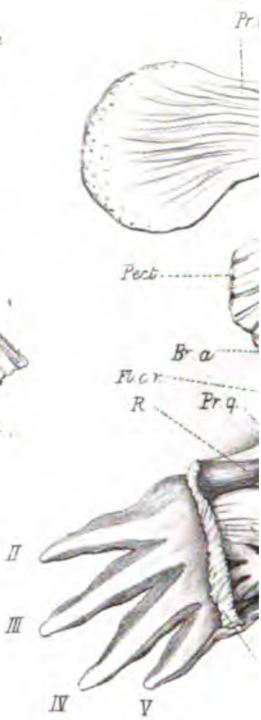
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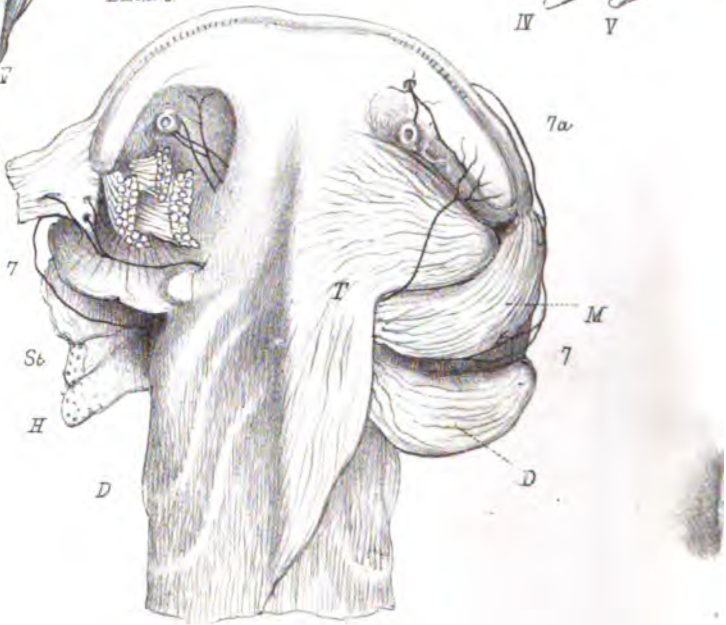
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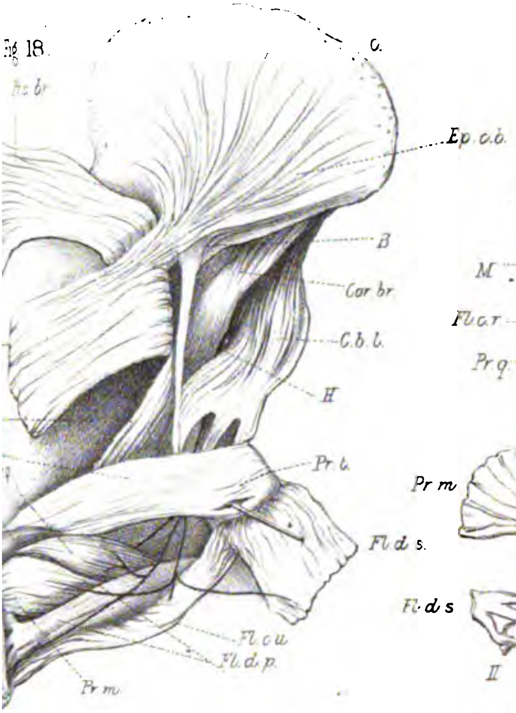
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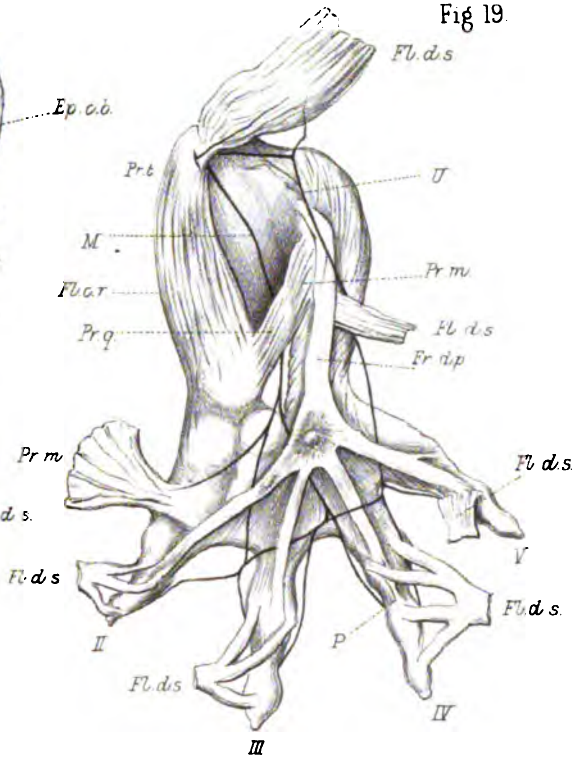
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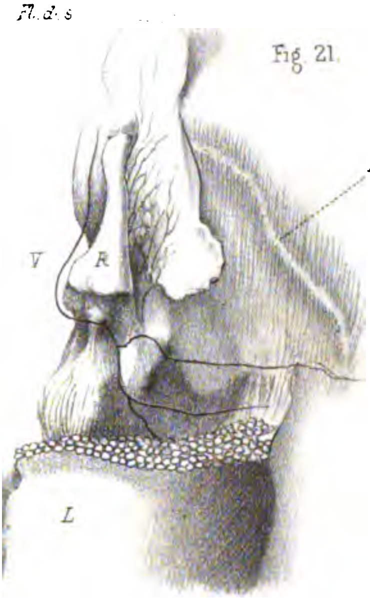

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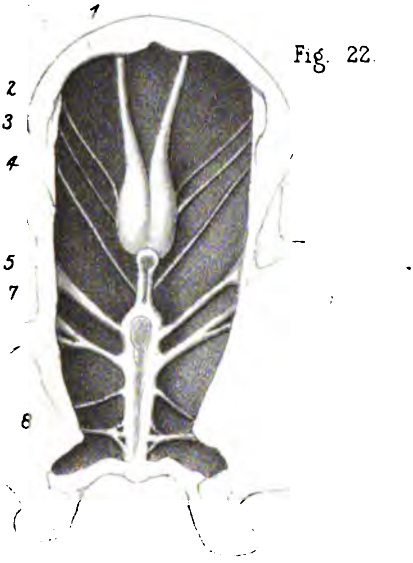

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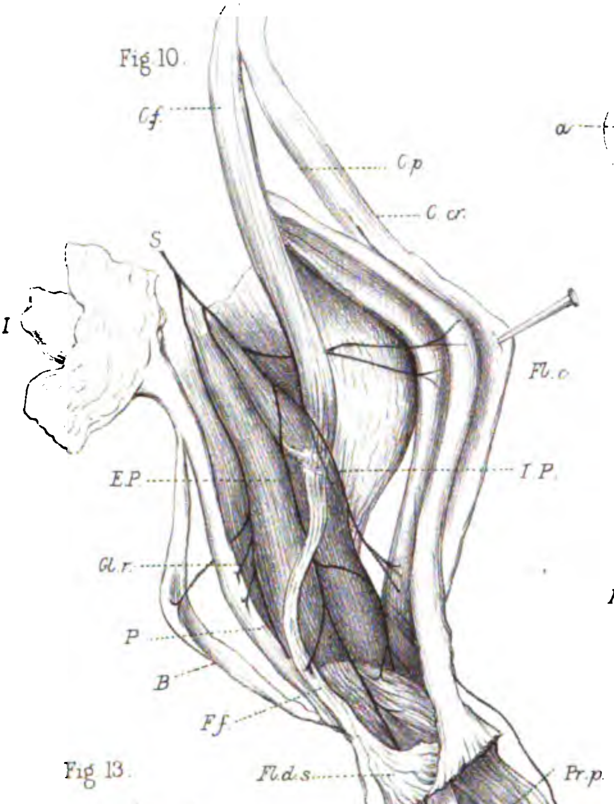
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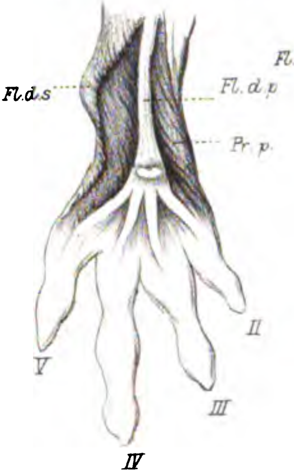
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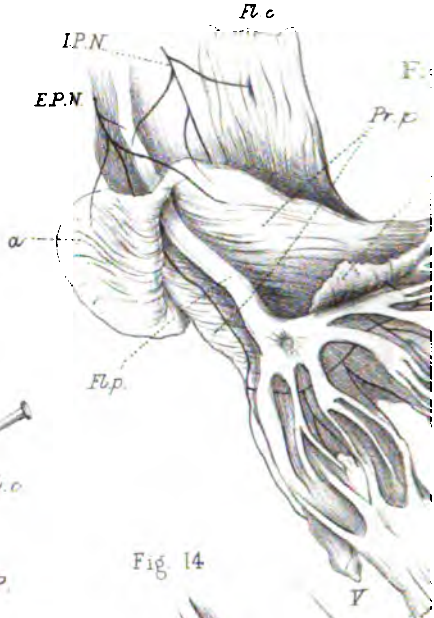
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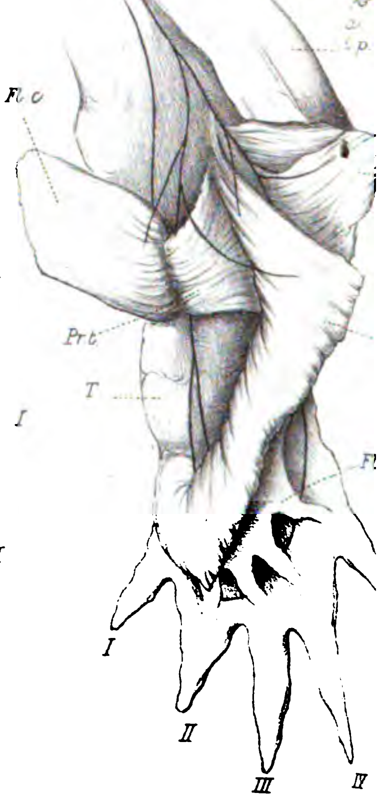
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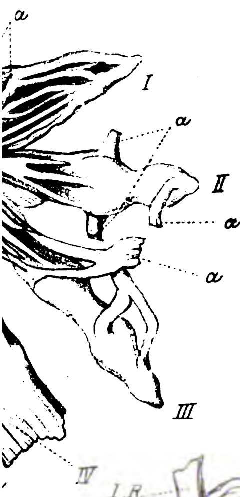
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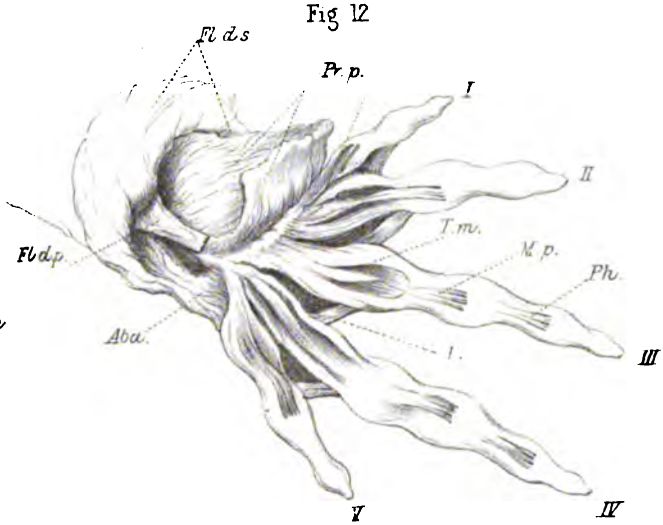
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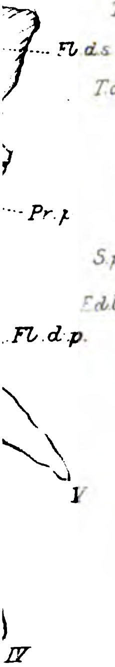
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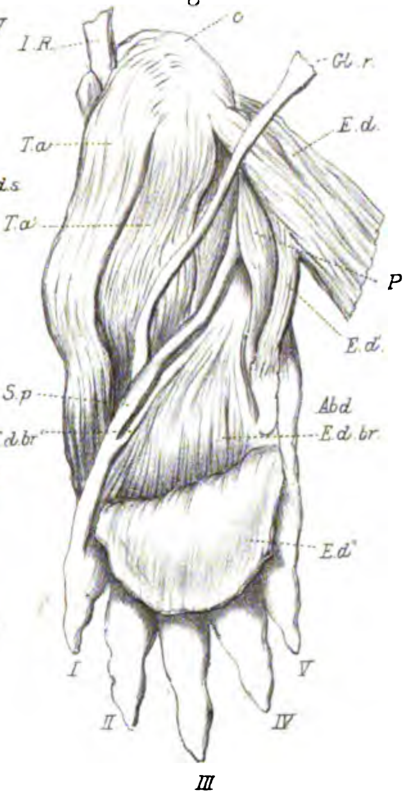
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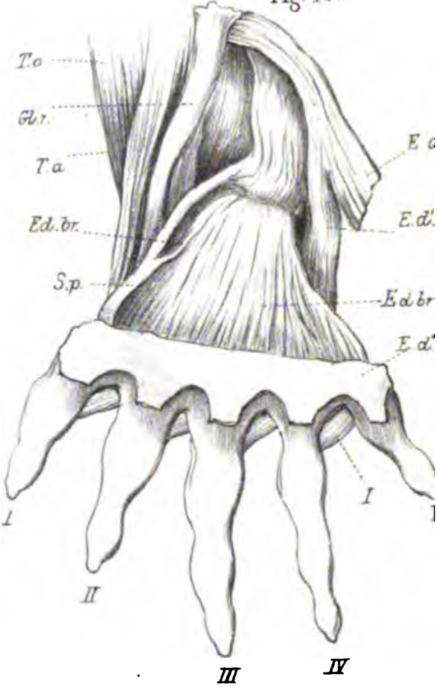
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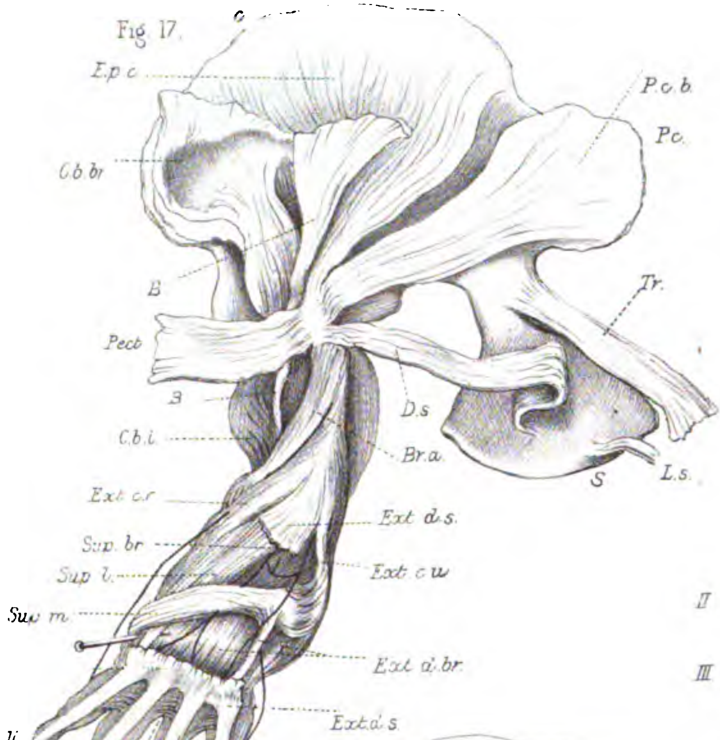
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C.b.br
B
Pect
B
C.b.l.
Ext.c.r
Sup.br
Sup.l.
Sup.m
II
III
T
IV
V
P.c.b.
P.c.
Tr.
D.s
Br.a.
S
L.s.
Ext.d.s.
Ext.c.u
Ext.d.br.
Ext.d.s.

Fig.

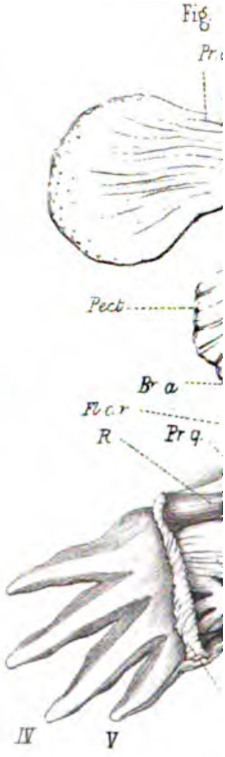
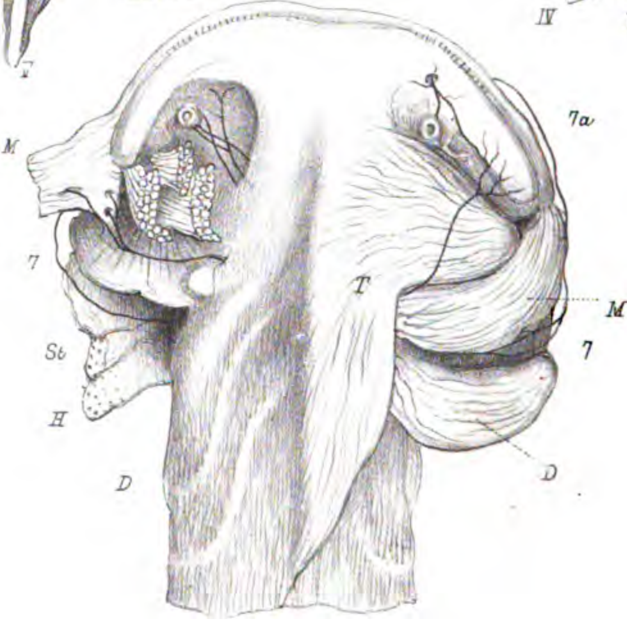
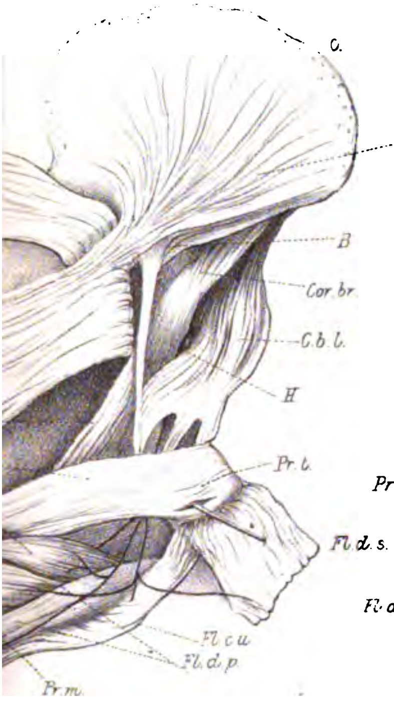

Pr
Pect
Br a
Fl.c.r
R
Pr.q.
II
III
IV
V

Fig. 20.


M
7
St
H
D
T
7a
M
7
D


c.
Ep.c.b
B
Cor.br.
C.b.l.
H
Pr.t.
Fl.d.s.
Fl.c.u.
Fl.d.p.
Pr.m.

d. s

Fig 19

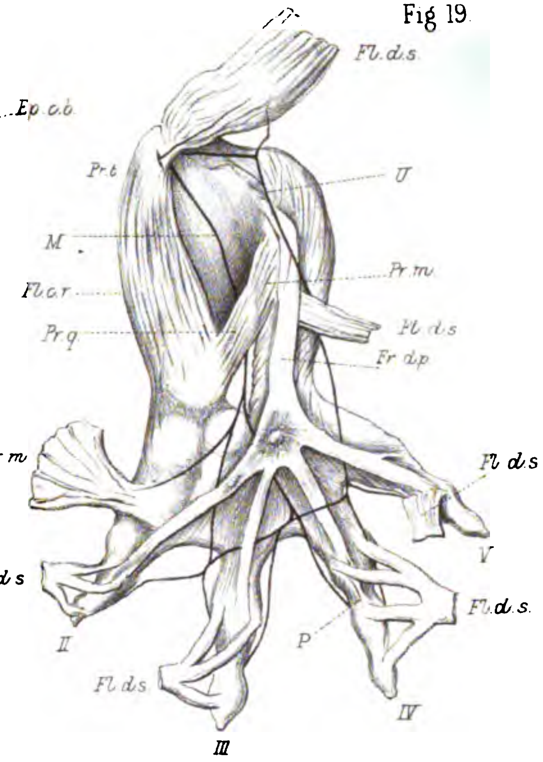

Fl.d.s
Pr.t
U
M
Pr.m
Fl.c.r
Pl.d.s
Pr.q
Fr.d.p
Pr m
Fl d.s
Fl.d.s
V
Fl.d.s.
P
II
Fl.d.s
IV
III

Fig 21

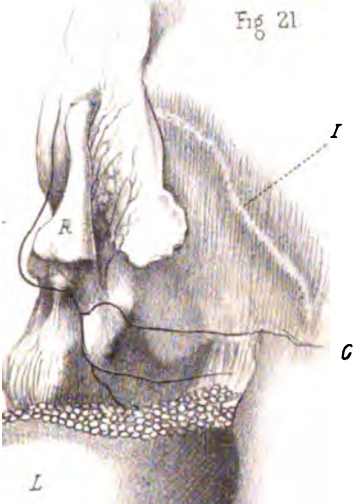
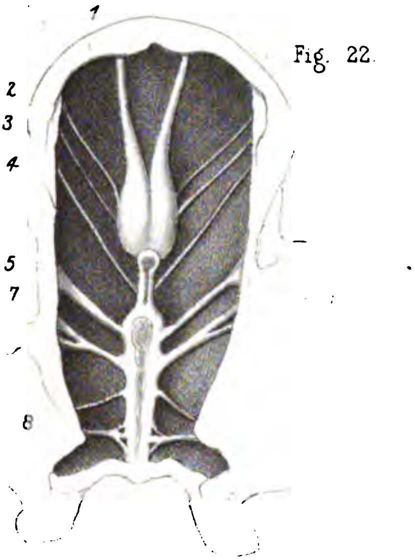
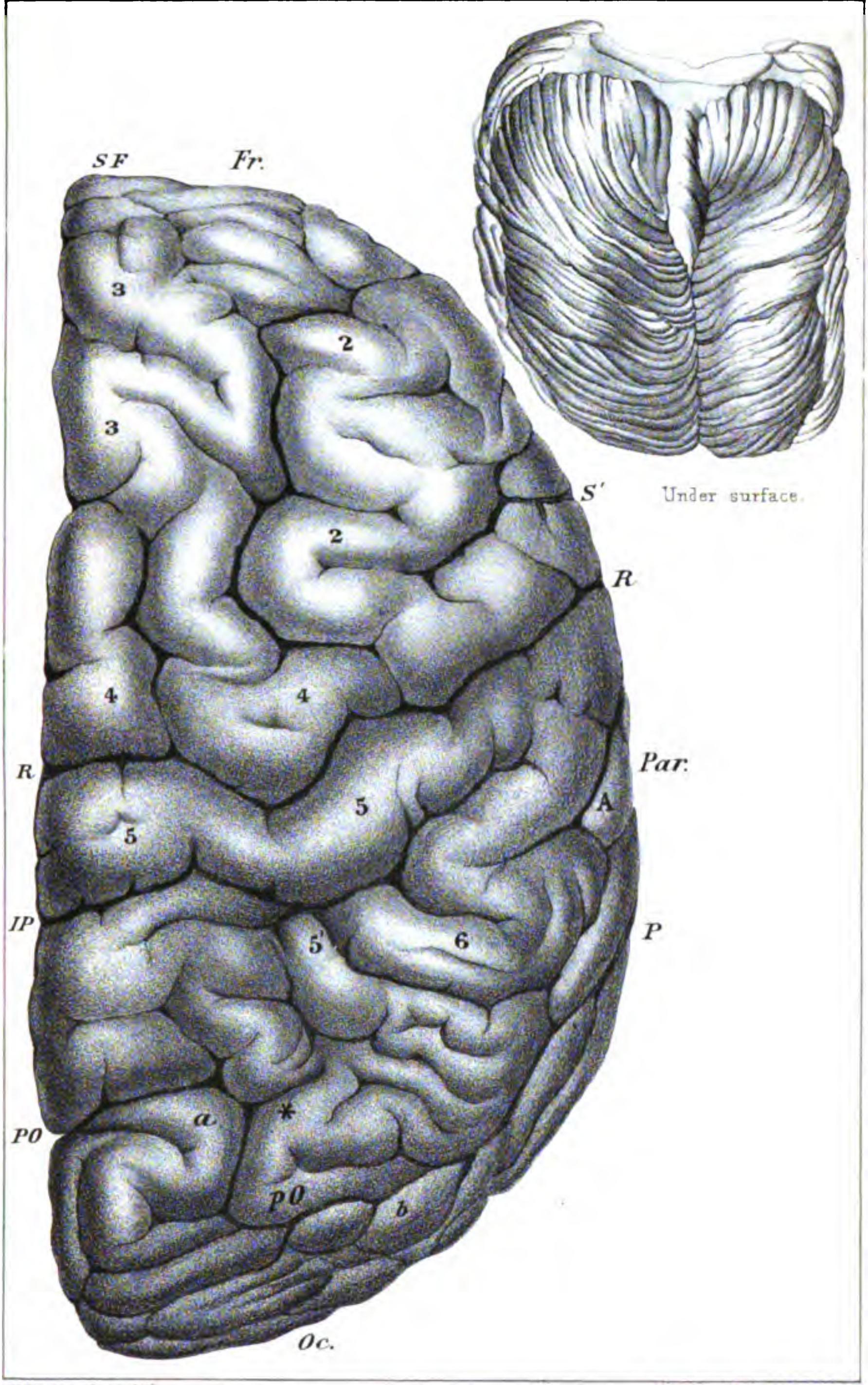


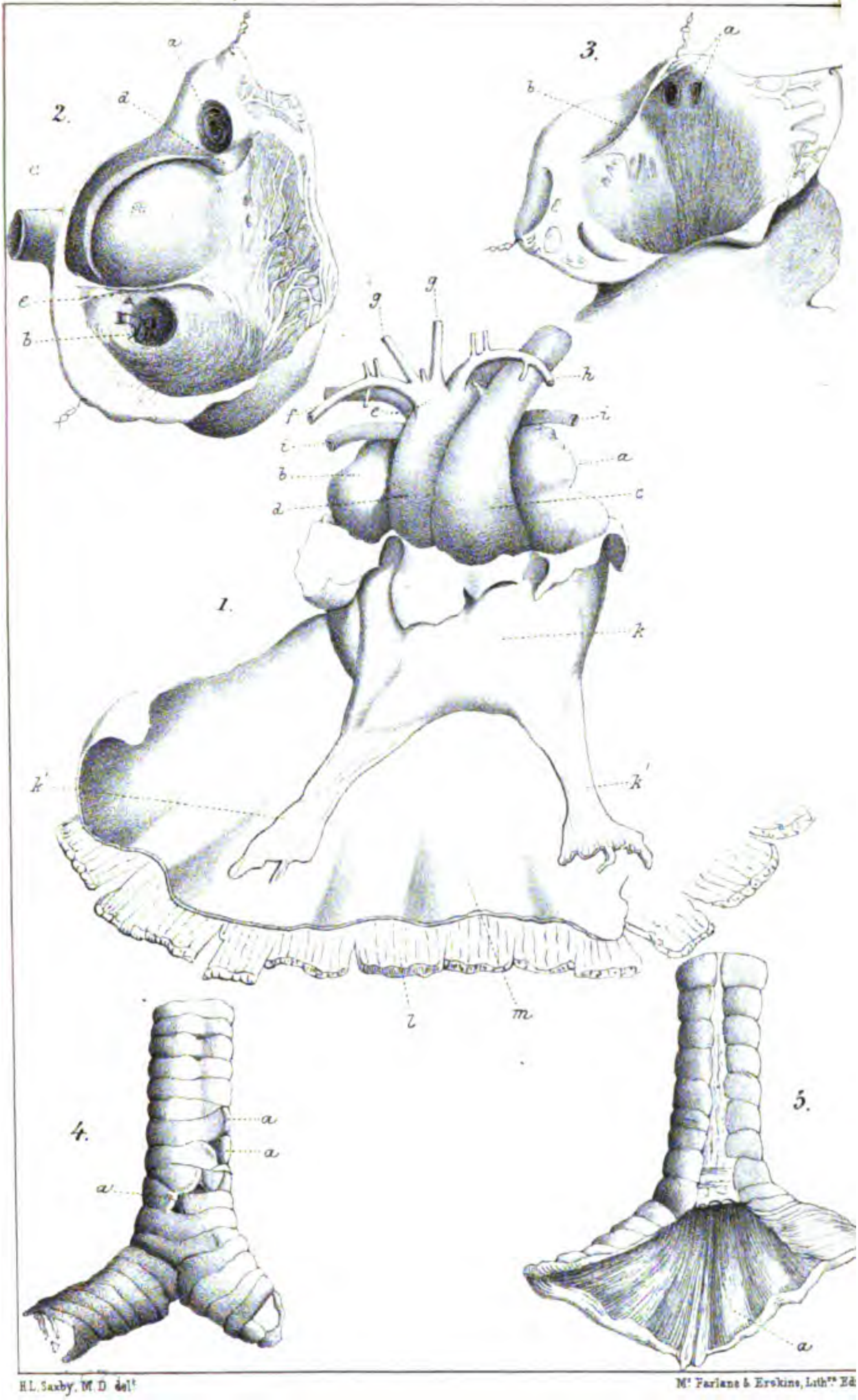
Fig. 22.




SF
Fr.
3
2
3
2
S′
Under surface.
R
4
4
R
Par.
A
5
5
IP
P
5′
6
a
*
PO
PO
b
Oc.

W. Searson, ad nat. delt. McFarlane & Erskine Lithrs Edinr

BRAIN OF AN IDIOT.

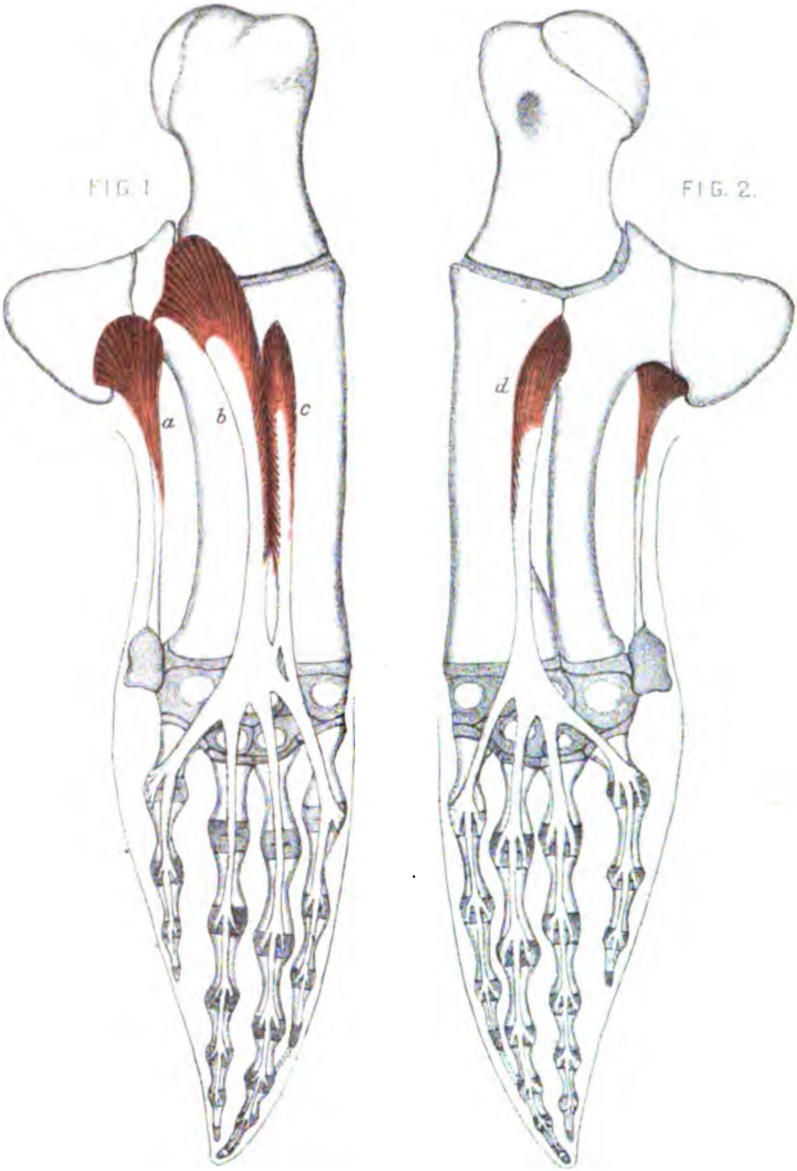

1.
2.
3.
4.
5.
a
b
c
d
e
f
g
h
i
k
k'
l
m

H.L. Saxby, M.D. del^t

M^c Farlane & Erskine, Lith^rs Ed

HEART & WINDPIPE OF ELEPHANT.

FIG. 1 FIG. 2.



Flexor and Extensor Muscles of the Fingers. $\frac{1}{6}$

FIG 1. Inner aspect. *a.* Flexor carpi ulnaris. *p.c.* Pisiform cartilage.
b. F. digitorum ulnaris. (F. profundus digitorum.)
c. F. digitorum radialis. (F. longus pollicis.)
FIG 2. Outer aspect. _ *d.* Extensor communis digitorum.

RUDIMENTARY STRUCTURES

J. Struthers, delt.

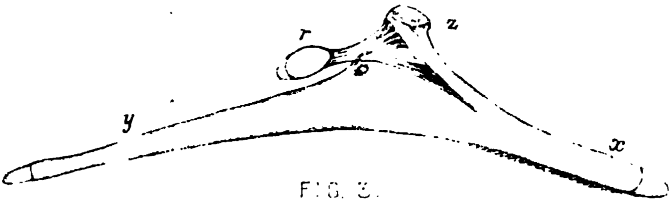


FIG. 3.

Bony rudiment of hind limb attached to pelvic bone where the three processes meet. Left side inferior aspect. $\frac{1}{6}$.
x. Ischial process (posterior) y. Pubic process (anterior)
z. Iliac process (external) r. Bony rudiment.

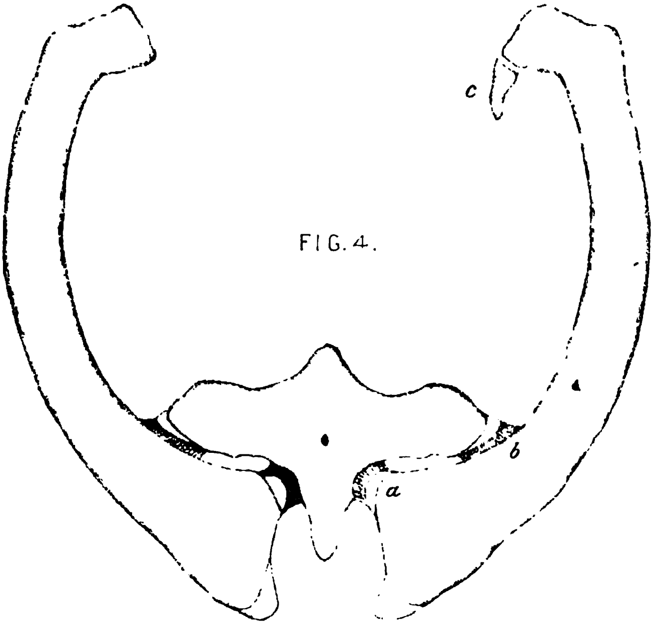


FIG. 4.

Sternum and first Ribs. $\frac{1}{6}$.
a b. The two costo-sternal articulations.
c. Separate capitular process.

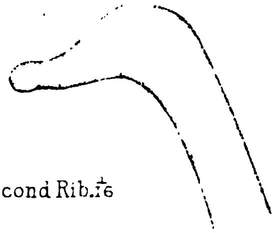


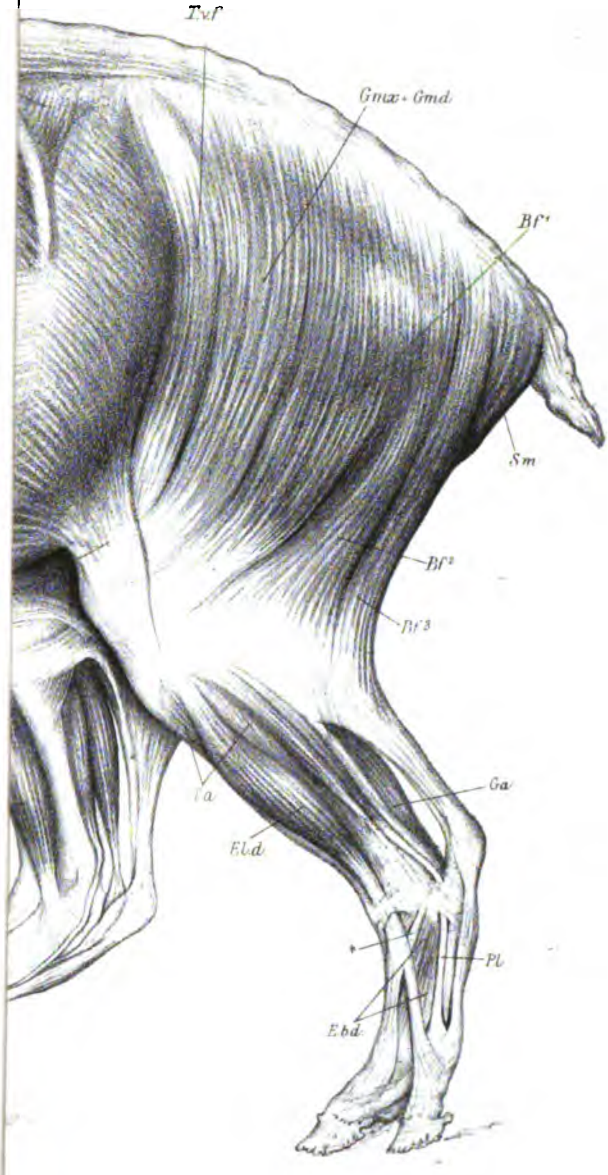
FIG 5.

Vertebral end of Second Rib. $\frac{1}{6}$

IN A GREAT FIN-WHALE.

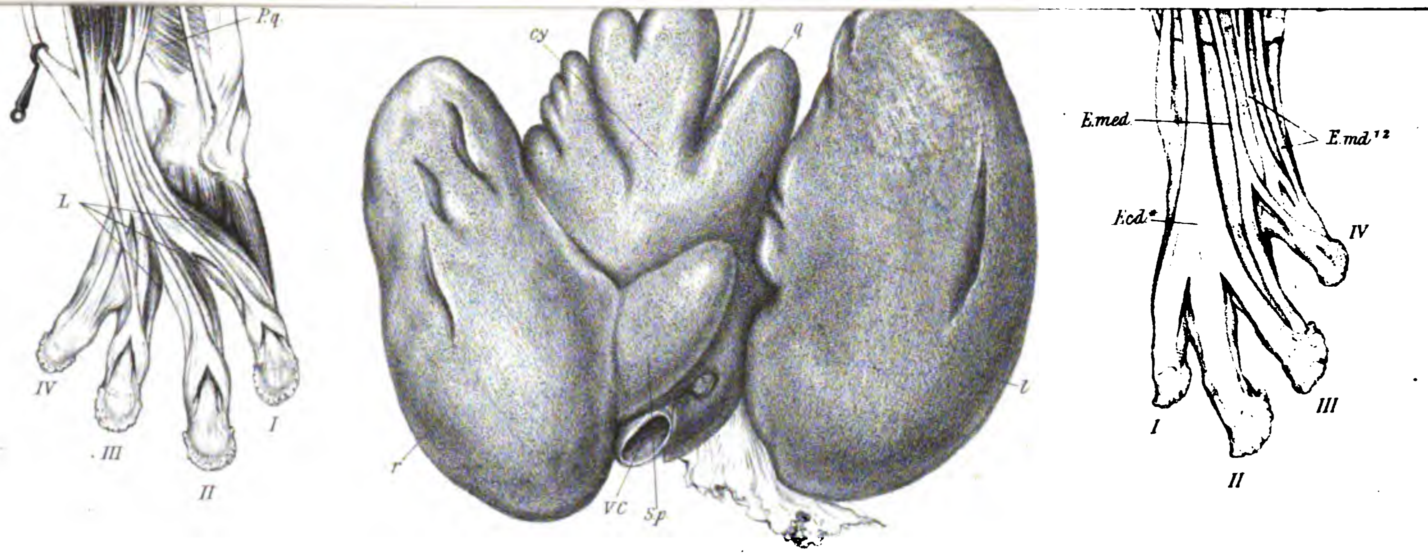
Keith & Gibb Lith^r Aberdeen

Pl. VIII.



Tvf
Gmx + Gmd
Bf^1
Sm
Bf^2
Bf^3
Ta
Eld
Ga
*
Pl
Ebd

Vincent Brooks, Day & Son, imp.


P.q.
L
IV
III
II
I
cy
q
r
VC
Sp
l
E.med.
E.md.¹²
E.cd*
IV
III
II
I

Pl. IX.

J. Murie, del.

C. Berjeau, lith

Vincent Brooks Day & Son, Imp.

LIVER, & VIEWS FORE LIMB OF TAPIR.

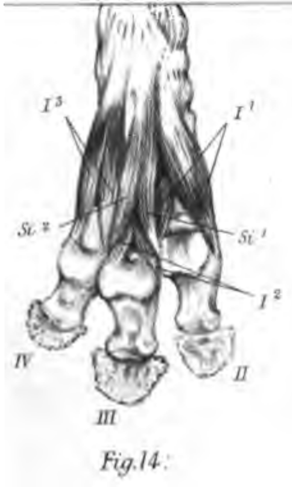

I 3
I 1
St. 2
St. 1
I 2
IV
III
II

Fig. 14.

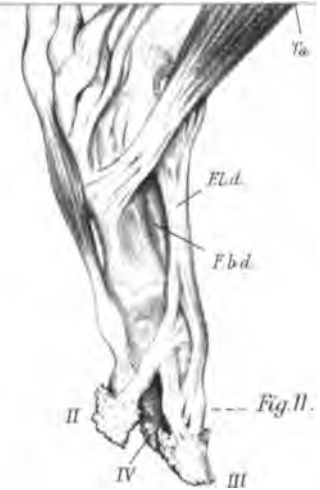

Ta
Fl.d.
F.b.d.
II
IV
III

Fig. 11.

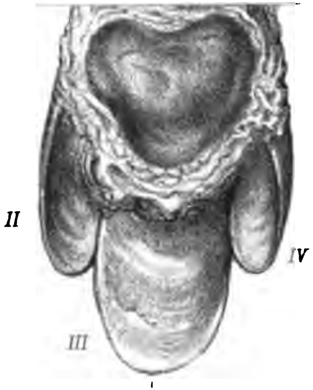


Fig. 10.

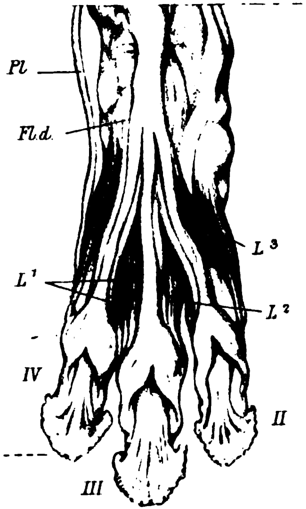

Pl
Fl.d.
L 3
L 1
L 2
IV
II
III

Fig. 13.

C. Berjeau, lith.

J Murie, del

Vincent Brooks, Day & Son, Imp.

NASAL ORGANS & VIEWS HIND LIMB OF TAPIR.

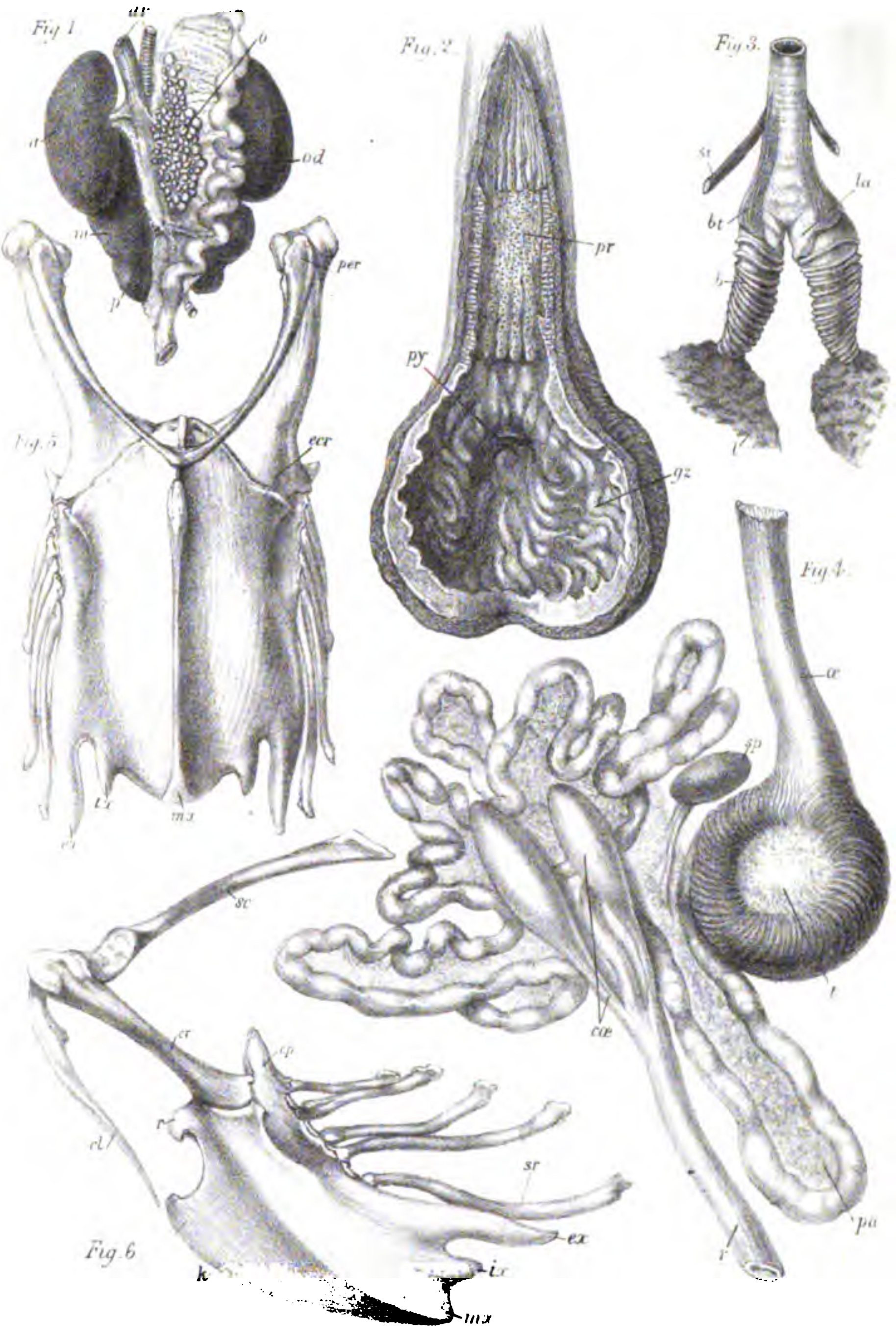


Fig 1
ar
o
a
od
m
p
per
Fig. 2
pr
py
gz
Fig 3
st
la
bt
b
l
Fig 4
ae
sp
t
Fig. 5
ecr
tx
mx
ex
sc
cæ
pa
r
Fig. 6
cr
cp
r
cl
sr
ex
k
ix
mx

Berjeau & Iterson del et lith

M & N Hanhart imp

PEL'S OWL, SCOTOPELIA PELI *Temm* ♀.

Fig. 23.

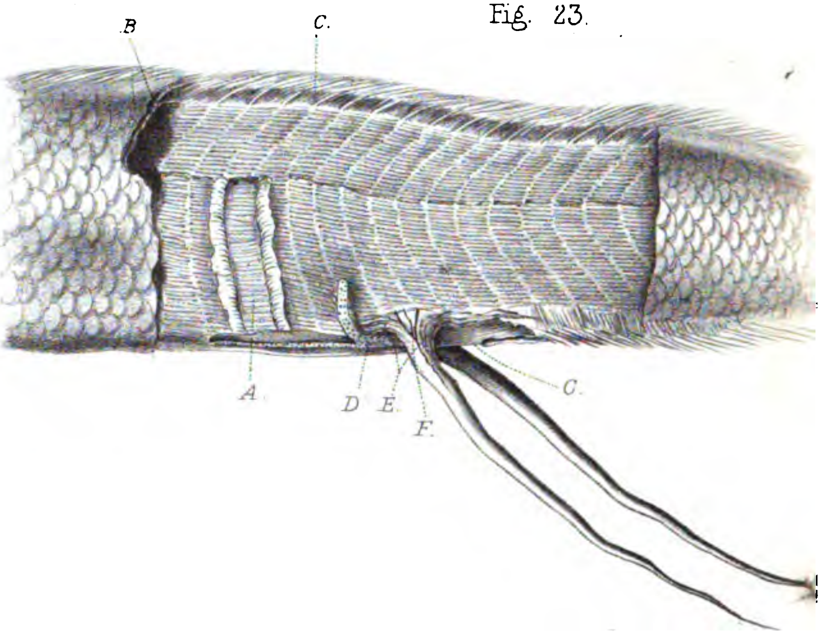
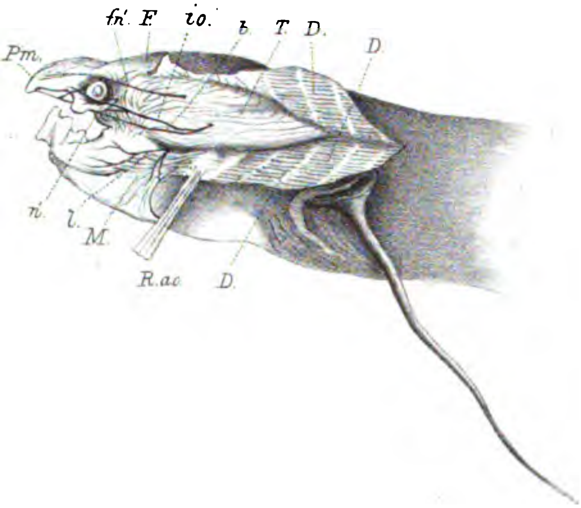


Fig. 25.


fn'.
F
io.
t.
T.
D.
D.
Pm.
n.
l.
M.
R.ac.
D.

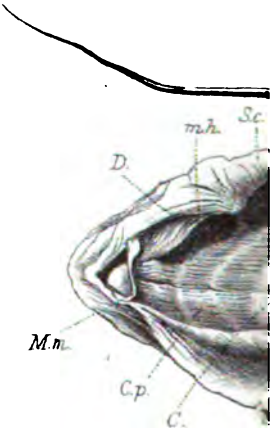

mh.
Sc.
D.
M.m.
C.p.
C.

Fig. 24.

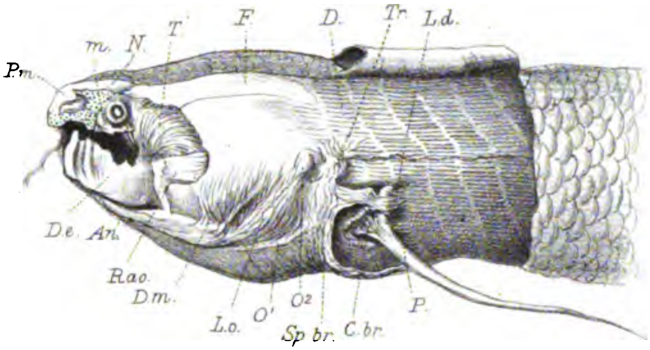

P.m.
m.
N.
T.
F.
D.
Tr.
L.d.
De.
An.
Rao.
D.m.
L.o.
O'
O2
Sp br.
C.br.
P.

Fig. 26.

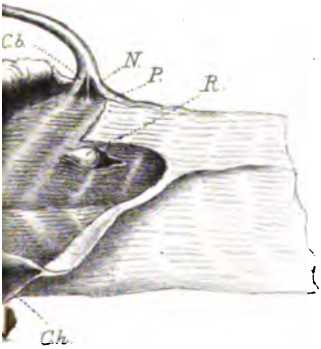
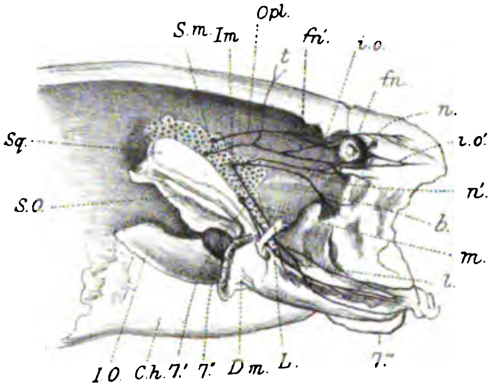


Fig 27.


S.m.
Im
Opl.
t
fn'.
i.o.
fn
n.
Sq.
i.o'.
n'.
S.O.
b.
m.
l.
I.O.
Ch.
7.'
7."
Dm.
L.
7."

University Press. Cambridge

Fig. 28.

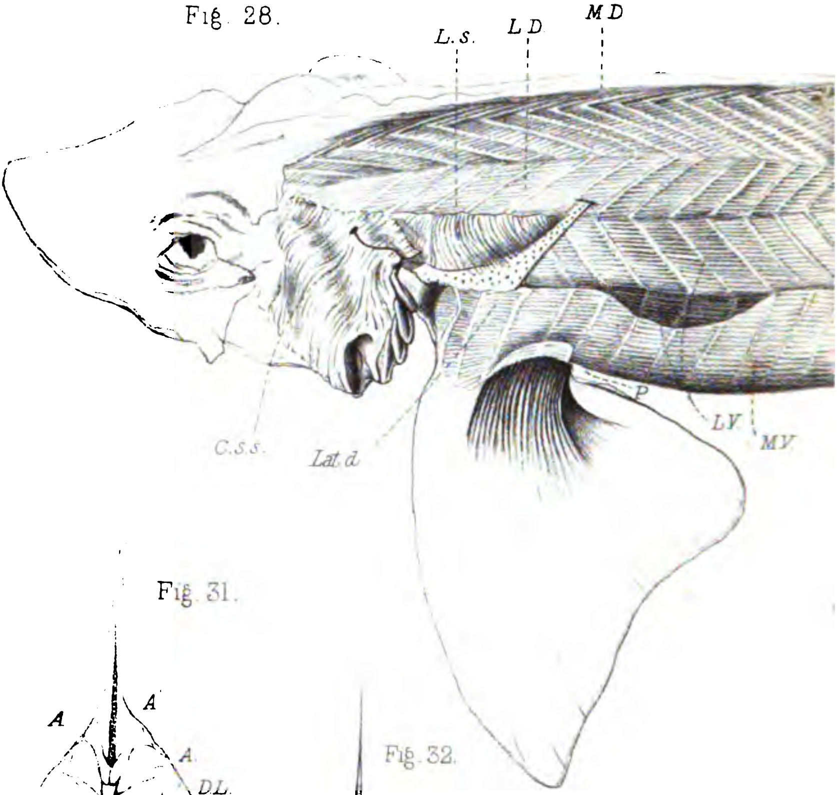

L.s.
L D
M D
C.s.s.
Lat. d.
P
LV.
MV.

Fig. 31.

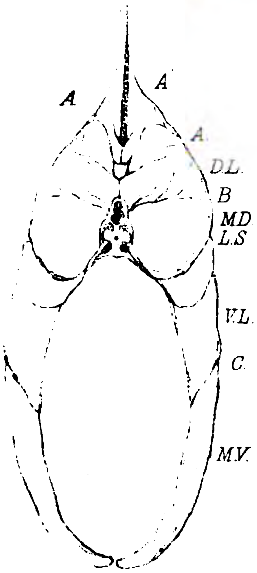

A
A
A.
D.L.
B
MD
L.S
V.L.
C.
M.V.

Fig. 32.

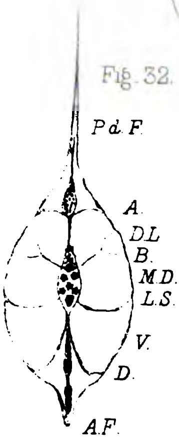
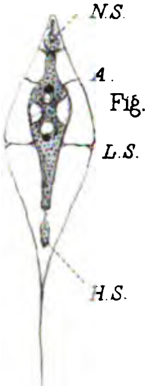
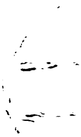

Pd. F.
A.
D.L
B.
M.D.
L.S.
V.
D.
A.F.

Fig. 33.





Dog F

Fig. 30.

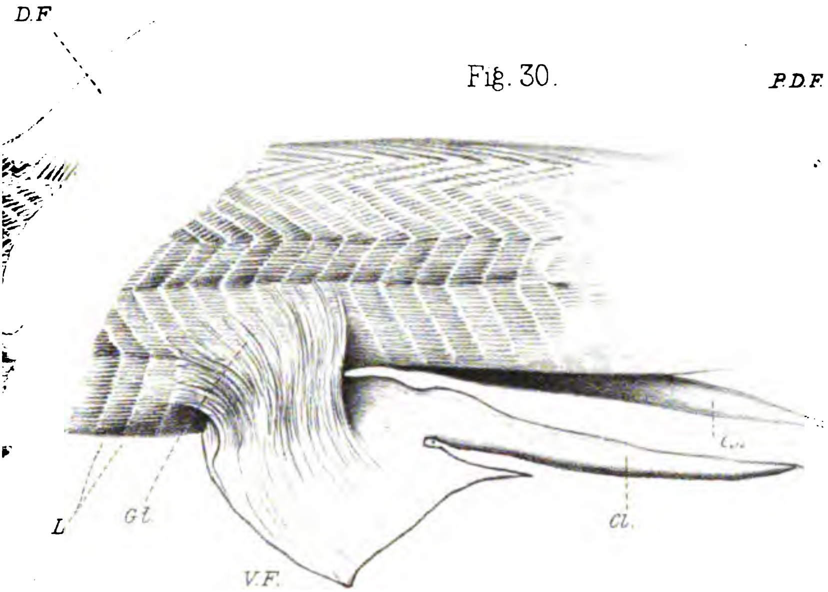
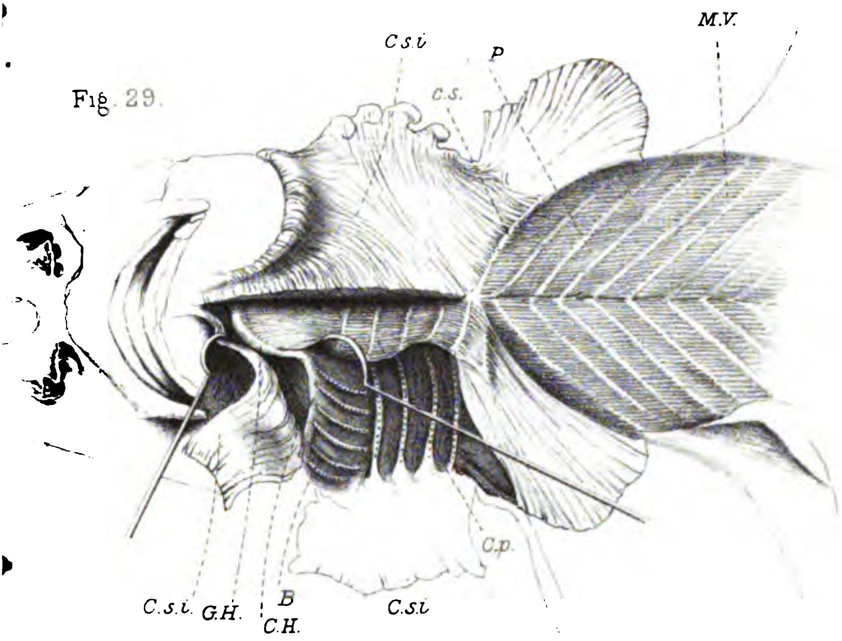

D.F
P.D.F
L
Gl
V.F.
Cl.

Fig. 29.


C.s.i
P
M.V.
C.s.
C.s.i.
G.H.
C.H.
B
C.s.i
C.p.

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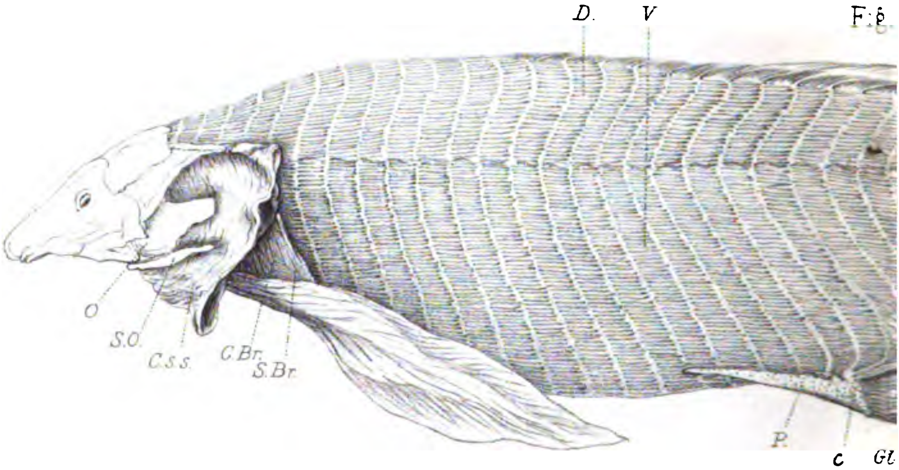

D.
V
Fig
O
S.O.
C.s.s.
C.Br.
S.Br.
P.
c
Gl

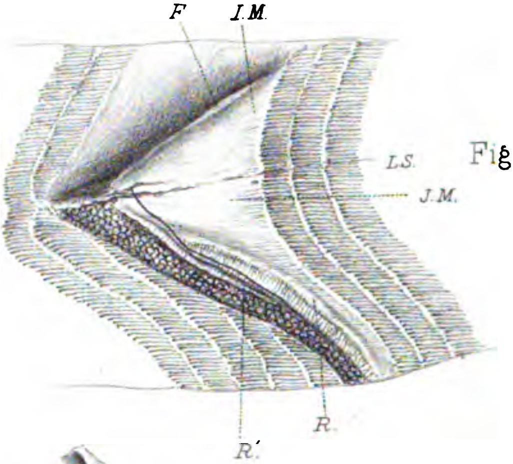


Fig. 35.

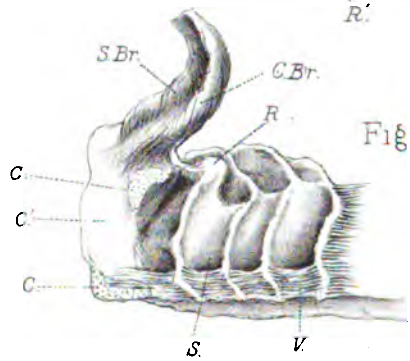
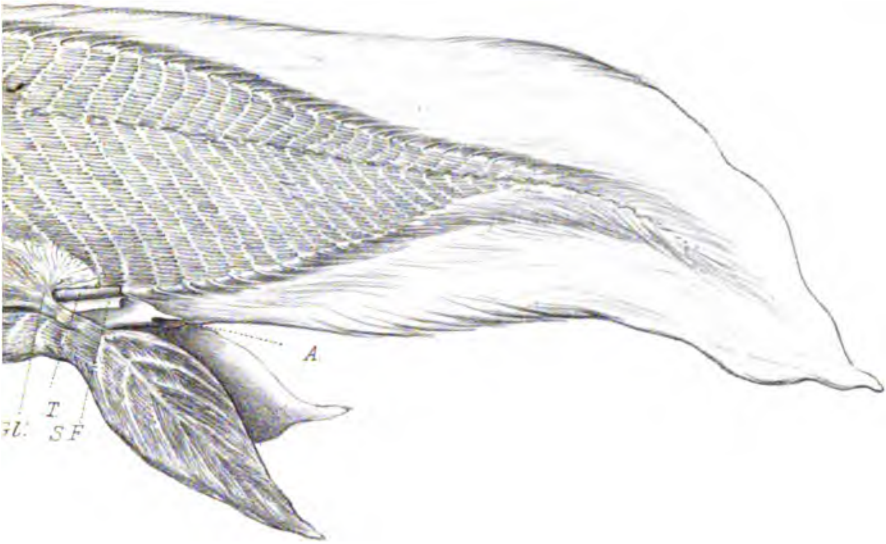

S.Br.
C.Br.
R
C
C'
C
S.
V.

Fig. 38.

Ceratod

34.



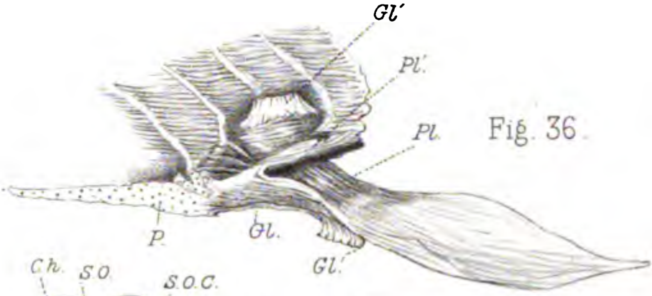

Gl'
Pl'.
Pl.
P.
Gl.
Gl'.

Fig. 36.

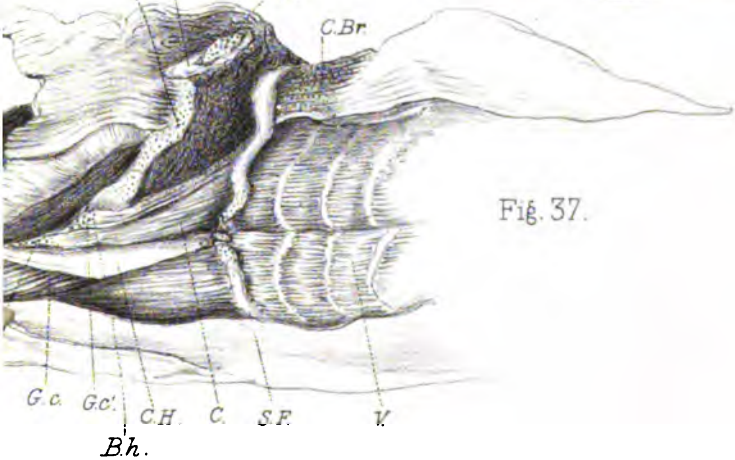

C.h.
S.O.
S.O.C.
C.Br.
G.c.
G.c'.
C.H.
C.
S.F.
V.
B.h.

Fig. 37.

University Press. Cambridge.

Fig. 39.

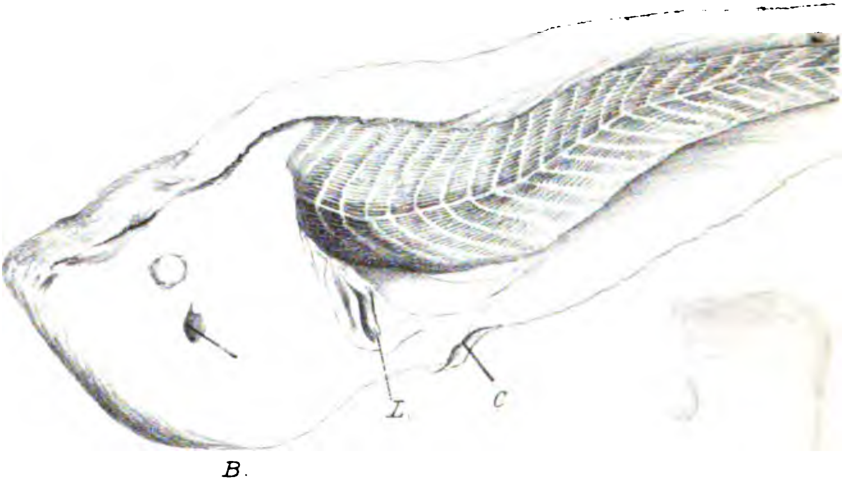


Fig. 41.

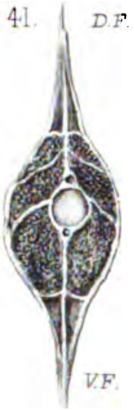
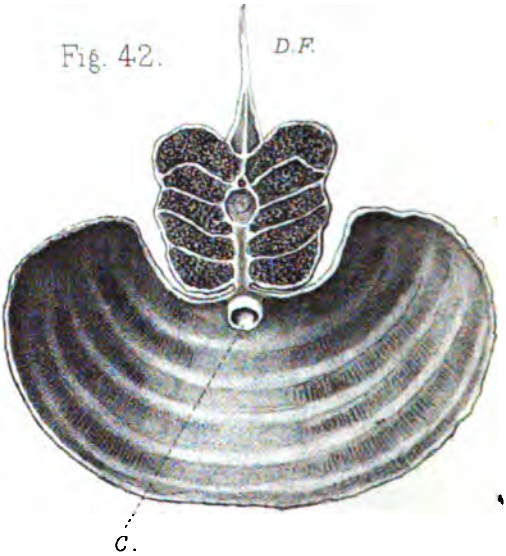


Fig. 42.



Pseudis Ta

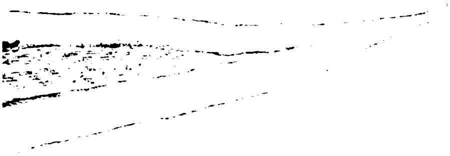


Fig. 40.

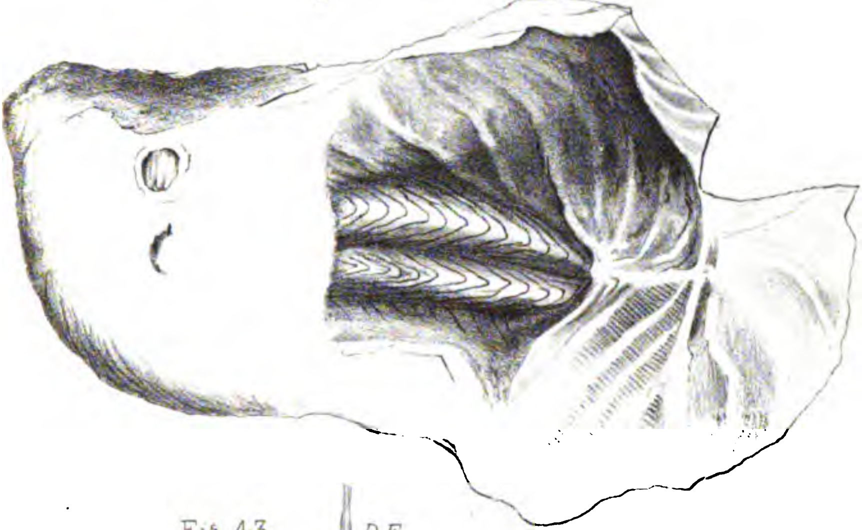
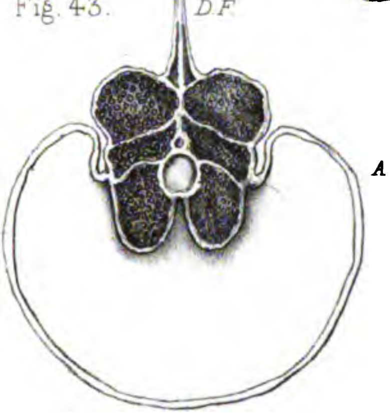


Fig. 43.



4.

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Fig. 44.

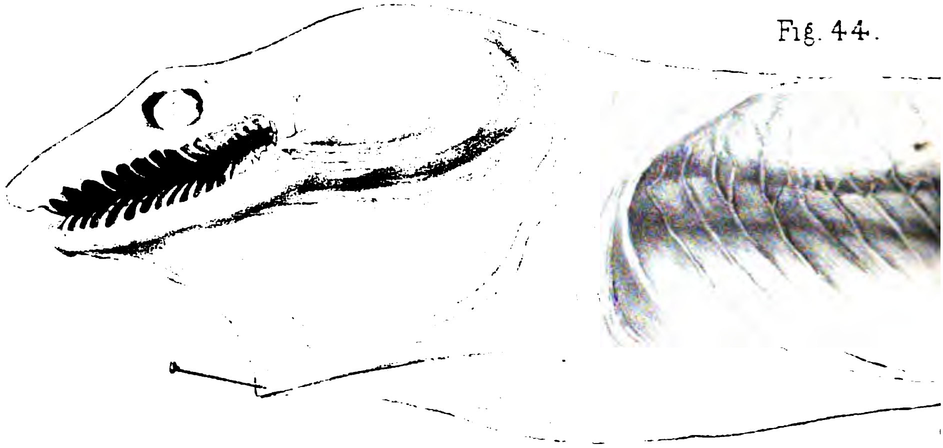
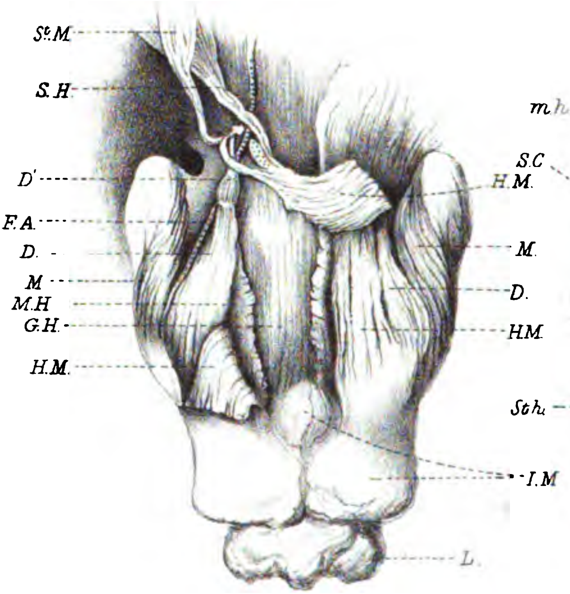


Fig. 47.

Fig. 46.


St.M.
S.H.
D'
F.A.
D.
M
M.H
G.H.
H.M.
H.M.
M.
D.
H.M.
I.M.
L.

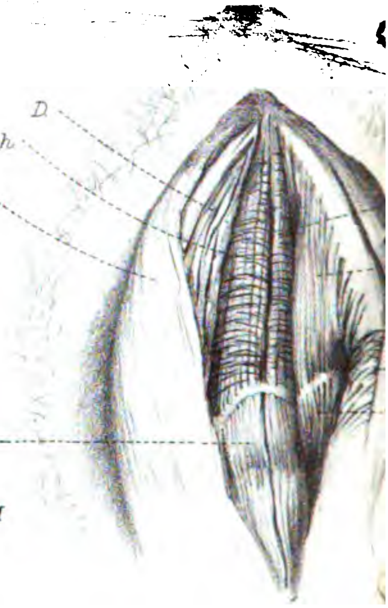


Fig. 45.

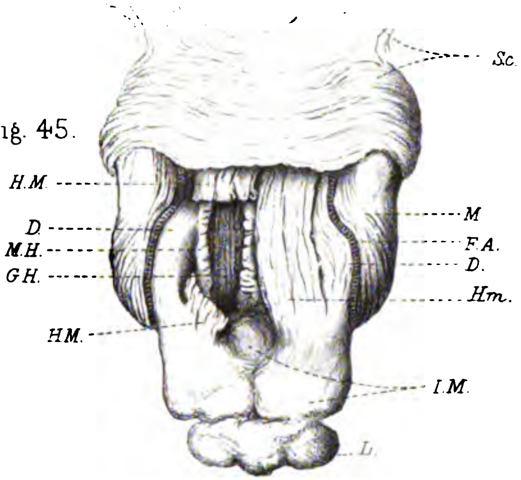
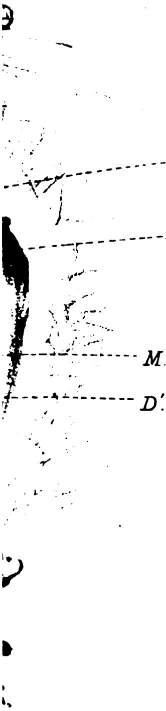
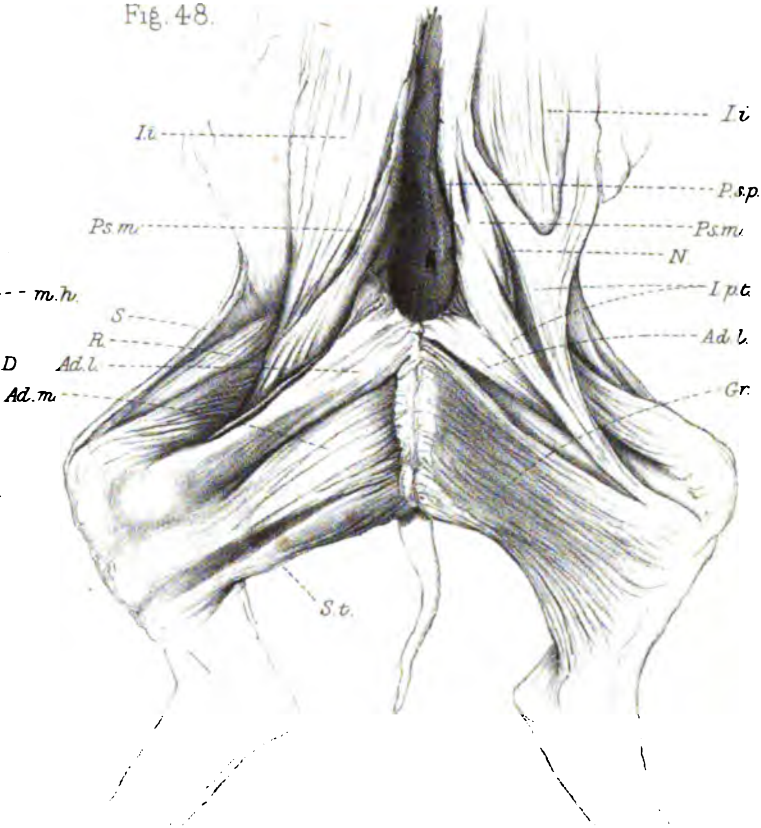

Sc.
H.M.
D.
M.H.
G.H.
HM.
M
F.A.
D.
Hm.
I.M.
L.

Fig. 48.

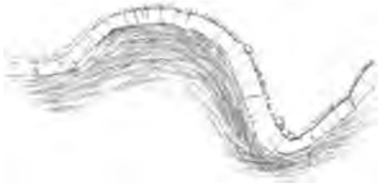



Il.
Ps.m.
S.
R.
Ad.l.
Ad.m.
Il.
P.s.p.
Ps.m.
N.
I.p.t.
Ad.l.
Gr.
S.t.

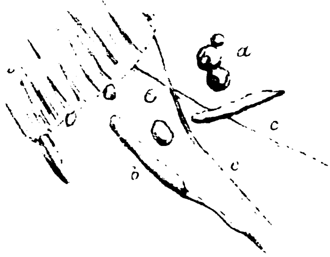
Snake (p. 317). Cat (p. 395).

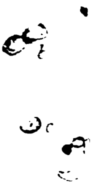
University Press, Cambridge.

1.



2.





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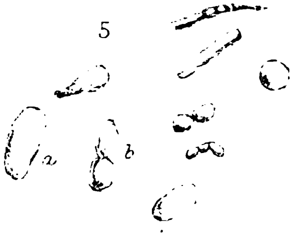

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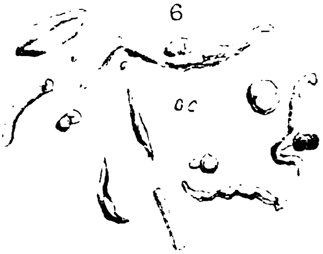

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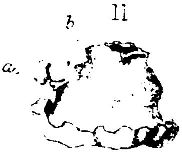

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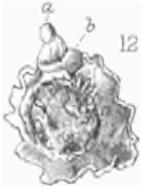

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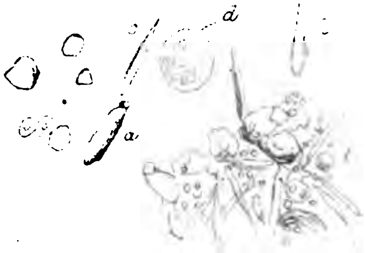

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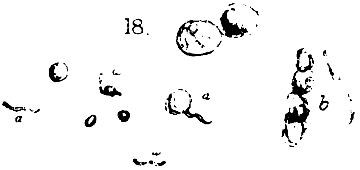

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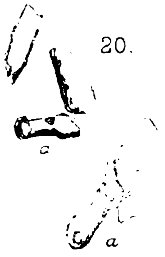

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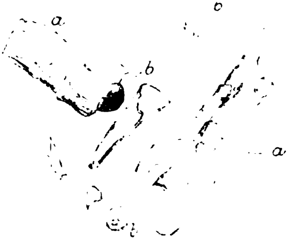

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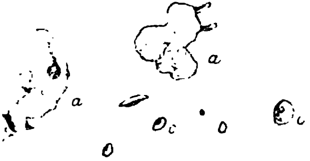

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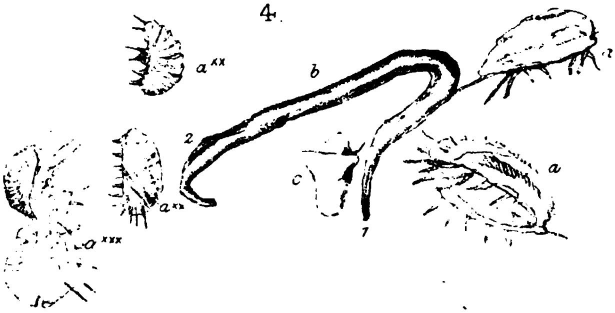
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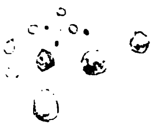

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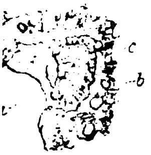

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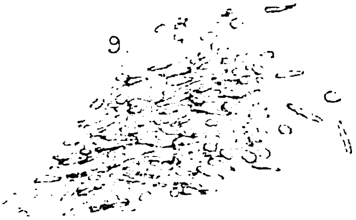

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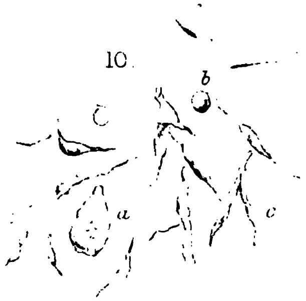

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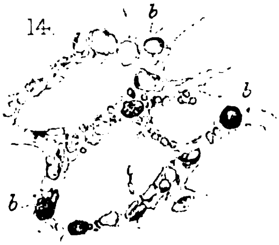

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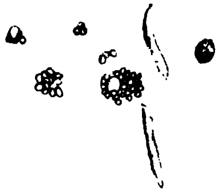

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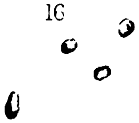

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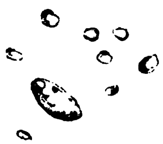

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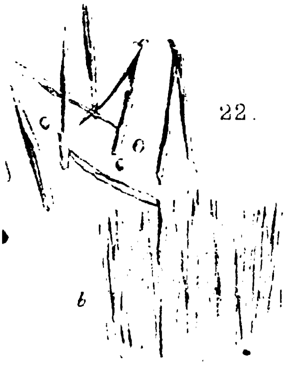

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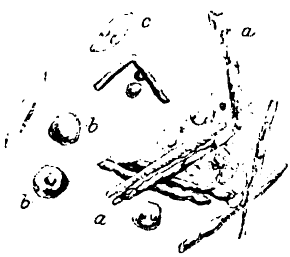

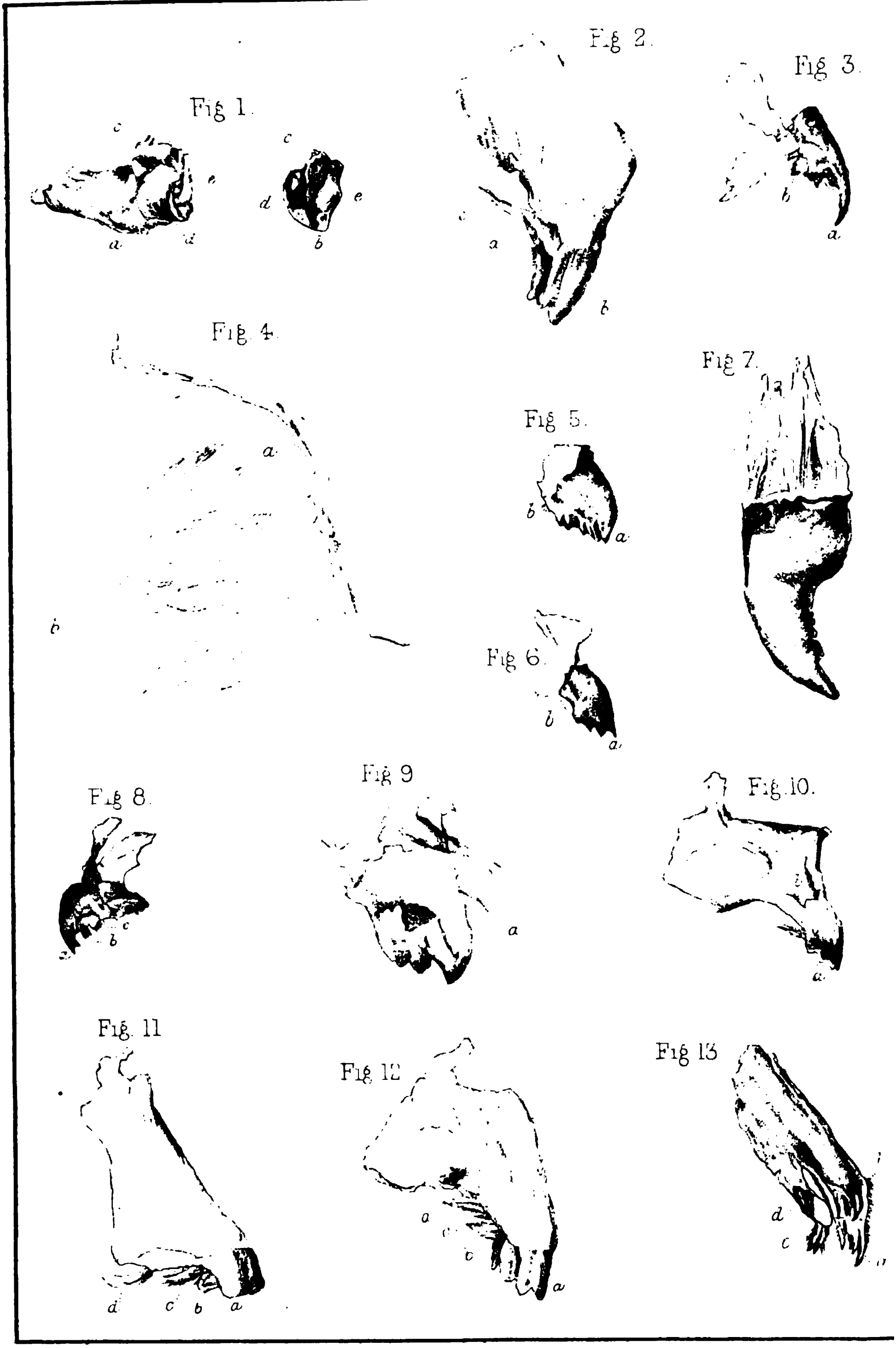
Fig 1.
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Fig 9
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Fig. 10.
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Fig. 11
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Mandibles & Maxillæ of Insects and Crustaceans. (p. 395)

University Press, Cambridge.

Fig. 1.

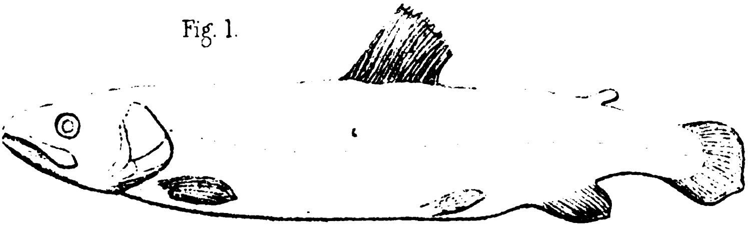
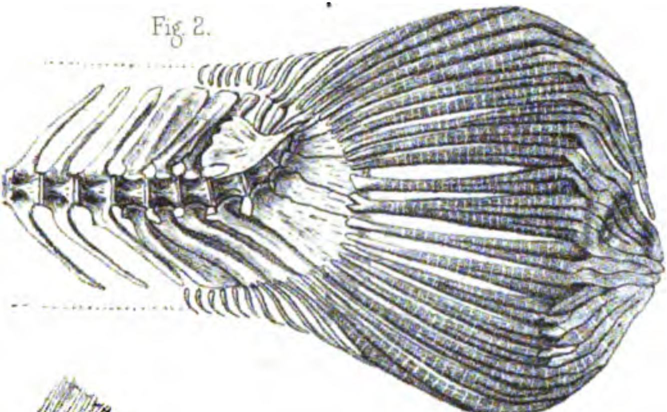
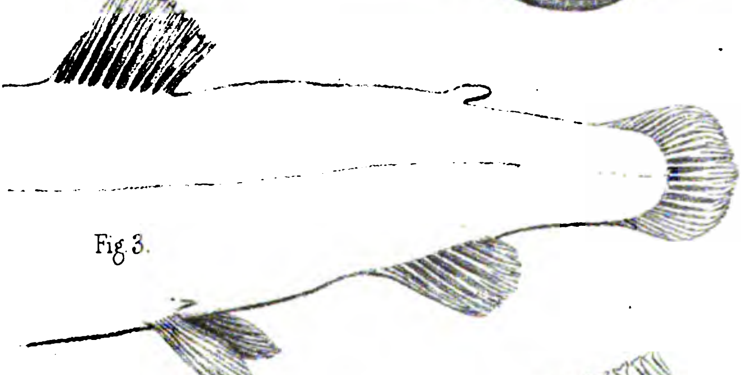


Fig. 2.





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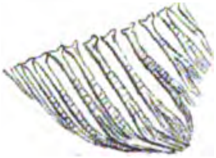

Fig. 4.

Tailless Trout of Islay.

Drawn on Stone by R.H. Traquair M.D. Forster & Co Lith Dublin

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